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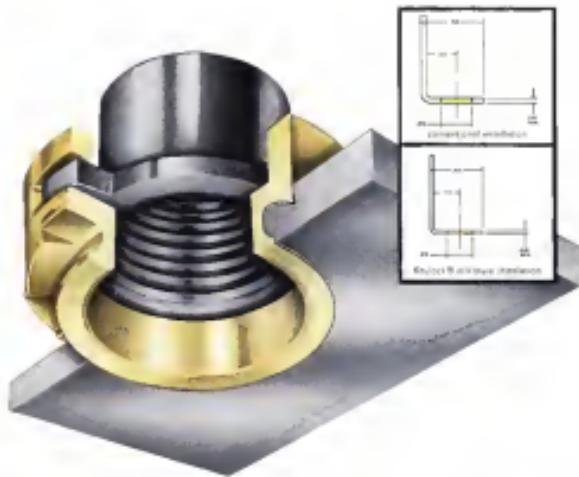
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Drone surveillance and reconnaissance give U.S. Army combat units a high altitude vantage point with much broader horizon from which to view battlefield action and terrain.

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“INTERDICT”

Silencing the Skies at Canaveral ... and what it means to you

Cape Canaveral, a serious r-f interference problem, and a group of experienced Capeshart engineers. This was our effort phase in the operation we call “INTERDICT,” for Interference Detection and Interruption by Capeshart Engineers. The exact nature and reason for that operation, and the engineering effort that is now available to all r-f installations, comprise our story.

You probably already know of the r-f interference experienced at the Cape. The large number of radiating and receiving equipments there were creating undesirable field conditions. Origin of these conditions was unknown. Capeshart engineers were called to analyze all the site's r-f sources—radios, telemetry links, communication equipment, etc.—and to predict and determine the interference sources. What they found is now history. Many of the spurious signals originated from higher harmonics of radar and communications systems. Once these had been identified and located, and other sources of r-f also isolated, the engineers of INTERDICT recommended ways to kill the noise, so that the skies over Canaveral could be silenced.

Next, Vandenbergh, After their analysis at Cape Canaveral, the Capeshart engineers were called to Vandenberg Air Force Base. Once again, r-f radiation was causing interference and hazard problems. Once again, the Capeshart INTERDICT team went to work: performed field measurements, analyzed various signals for carrier frequency and source amplitude instrumentation and r-f equipment functioning at Vandenberg. As a result of Capeshart recommendations and countermeasures, the noise could be silenced at Vandenberg, too.

If you have r-f problems or r-f interference on any military or industrial communications, electronics equipment, the engineers from Capeshart can help. Once again, their background in this field is unparalleled, and their experience and knowledge of all current types of equipment can now be offered to all. This is the first such service we have had, and we're proud to make it available.

Note: As you well know, interference and noise can come from a variety of sources. Spurious transmitter and receiver signals are closer in frequency to electronic instruments of any complexity. Our function is to determine what is interfering with who, and to take the correct remedial action. We also perform diagnostics as in possible electromagnetic radiation hazards to personnel, equipment, animals or food, and suggest the proper remedies for these hazards.

In short, Capeshart's INTERDICT service is performed in compliance with all applicable MIL Specification and system requirements. INTERDICT, under the direction of Dr. Jason R. Vagianos, offers, for example, world-wide, packaged services for the prediction, detection and elimination of r-f interference, personnel and material hazards. To learn more about these services contact:

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GEI's counter assembly is internally latched. This means soft, slow right-right where you need it. (GEI pioneered this development.) For faster, easier, more natural readability, the large numerals are arranged horizontally and designed in accordance with A.M.E.L. recommendations.

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EDITORIAL

Good Luck, Astronauts!

A special breed of generalist for Space Technology Leadership

America's dramatic accomplishments in space technology are made possible not only by developments in science, but by advances in technical management concepts. A new type of generalist has emerged to meet the demands of systems engineering and technical direction of complex missile and space projects. This technical manager combines a broad knowledge of science and engineering with the leadership capability to fuse the disciplines of creative specialists into a dynamic, effective team. In its six years as a principal contractor for the Air Force, NASA, and AFPA, STL's hard core of technical management generalists has set the pace in developing new members of this very scarce breed. Their unique ability is the prime asset in Space Technology Leadership. Scientists and engineers who would add this new management dimension to their professional careers are invited to submit their resumes to STL, where they will receive meticulous attention.

SPACE TECHNOLOGY LABORATORIES, INC., P.O. BOX 19005-A, LOS ANGELES 45, CALIFORNIA. A subsidiary of Thompson-Houston Worldwide Inc.

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With the designation of three of the seven original Astronauts to make the initial ballistic trajectory flights atop a Redstone missile, the Mercury program has reached a point of no return psychologically if not technically. This selection has pretty well resolved any doubt that may have existed whether Mercury would be pushed to its conclusion of uncrewed orbital flight and unless it crystallized that the United States and the Soviet Union are again competing in a significant phase of the fierce technological race that began in the early years of the last decade.

In the Mercury project, the United States is again engaged in a steep climb, with the odds heavily against its winning by recovering the first man also from orbital space flight. Once again, it is primarily the major discrepancy in booster power that has relegated the Mercury project to its than class of the Soviet Comets. For it has been the meticulous minuteness required to cramp all of the necessary equipment within the rigid 2,300-lb weight limit of the Mercury capsule that has caused the longest delays in the Mercury schedule. This rigid capsule weight limitation was necessitated by the limited booster power available from the Atlas—the most powerful booster now ready. With the power from the Soviet boosters that landed the 10,000-lb capsules of Sputnik IV, V and VI not yet available for the U.S. program, it is likely that Mercury could have come close to its original schedule of attempting its first uncrewed capsule orbital flight in November, 1960.

In addition to its technical contributions in opening a vast new area to manned exploration, the competition between the U.S. Astronauts and Soviet Cosmonauts will have enormous impact on international prestige. The progress of these two national efforts to put man into space is being followed with great interest all around the world, and the prestige inherent for the war may well be great.

Although the prestige aspects of the Mercury program have grown most important since its inception, it has a sound technical foundation and is aimed at valid scientific achievement. It is a genuine pioneering effort in advancing man's capability to explore his environment and not merely a publicity stunt or the delivery of serial rights for a national emblem.

Mercury fits roughly in the middle of a curving thrust-plane curve of the history of aeronautical flight. The first is the post World War II X-15 program, which is scheduled to reach its ultimate performance of 4,000 mph and 290,000-ft altitude shortly. The maximum X-15 performance is still less than a quarter of the speed required for orbital flight, and its altitude peak just nudges at the edge of space. Beyond the Mercury and the Dyna-Soar programs, which although currently only planned and funded through suborbital flight, is aimed at eventually producing reusable vehicles that can perform serial missions in orbital flight.

The principal technical goal of Mercury is to determine whether man can survive and function in space flight. The Astronauts will have a variety of functions to perform during their planned triple orbit of earth and 4½ hr of weightlessness, including changing the attitude of their capsule, making single navigational calculations and monitoring the automatic phases of their capsule operation. The basic expertise from

these Mercury flights will provide the foundation on which Dyna-Soar, Apollo and other national scientific and military space vehicles can build.

There is not sufficiently detailed data available for a comprehensive comparison of the Soviets' Comet program with Mercury, but some landmarks are visible. The Soviet launching of five-ton orbital capsules in Sputnik IV, V and VI last year was significant milestones in their Cosmonaut program. The fact that dogs and other forms of life were successfully recovered in one of these attempts demonstrated the operational capability of the Soviet system but induced a more sober evaluation of its reliability, even by the Russians. They have been exceedingly cautious in their predictions on manned orbital flight since the experiments and have stressed the high level of reliability and safety necessary in an orbital mission before it can be entrusted with human passengers.

The nature of the Russians' re-entry success and fail also indicates that they are using a basically different approach to the problem than the relatively simple ballistic reentry system of Mercury, whose reentry was demonstrated so effectively in the recent MA-2 shot with an empty capsule. It appears likely that the Soviets will use a heavier capsule for their nominal orbital flights rather than the non-reusable Mercury type capsule. Again, this is probable because of the greater thrust available from their boosters.

A good "guarantee" for the first Soviet manned orbital attempts would probably be late spring or early summer. This is based on their proven determination to stay the wastewater international prestige learned from their space achievements by being first, and on the knowledge that it will be considerably before the last of the three Astronauts picked for space flight could be ready to make the first attempt at orbital flight, with perhaps early fall in a more remote date.

The three Astronauts, John Glenn, Virgil "Gus" Grissom and Alan Shepard, are now undergoing the final 60 days of intensive training for the initial space flight in a one orbital path using the Redstone booster. These preliminary flights, the last test of man and capsule, will probably be made in mid-April, and on their results will depend much of the final scheduling for the crucial orbital attempts.

The aerospace fraternity will understand the bounds involved in man's first attempt at space flight, despite all of the intensive training given the Astronauts and the best technical efforts to make their equipment sound. Since those first December days at Kitty Hawk, test pilots have stood on their toes on the same brink of the unknown, willing to risk their lives in an attempt to advance the technology of man's past effort to leave his earthly home. Man has paid the full price of that loss in these attempts, and the possibilities of experimental failure always run with those with the courage to explore the unknown.

The American people should understand fully the courage and devotion of the seven Astronauts who will sacrifice for what will probably be the most exciting venture of man in this era. With that understanding, a fervent "good luck" also should go to the third—Glenn, Grissom, Shepard—who have been picked to attempt the initial flights.

—Robert Hora

Washington Roundup

Pentagon News

Blackout

Watch for an incoming blackout of Defense Department sites for policy rather than security reasons. Last weekend was the drastic reduction of information on Defense research facilities. The other of Arthur Schlesinger, assistant defense secretary for public affairs, cut the press release material from seven pages on Defense's X-15 to 45 words in December X-15. No security was involved in the cuts, since most of the material deleted had been contained in earlier Defense press releases. First evidence of the Schlesinger policy aimed at eliminating participating contractors' names from Pentagon press releases also appeared in the above-mentioned December material.

Informed Navy experts say antiaircraft warfare can be expected in view of recently revised estimates that India-Russia will have 18 guided-missile ships by 1967. Army will prepare its Nike system for antiaircraft defense against the airborne threat.

Soviet Marshal Vasilii Soloviev said last week that nuclear and rocket equipment of Russia's army and navy will include preparations at an unprecedented level, and strategic rocket forces have been established as the principal arm of the armed forces.

Newly-constituted members and staff of the National Aerospace and Space Council now are expected to be named soon, but legislative complications still are delaying formalization of the chairmanship by Vice President Lyndon Johnson. The law requires the President to hand the council.

Subcommittee on Central Intelligence Agency and National Security Agency under Rep. Paul Laxalt has been created in the House Armed Services Committee, partly to facilitate a House move to establish a separate committee on intelligence. House Rules Committee will continue hearings this week on other proposed intelligence committees.

Four-day review of the Rover nuclear reactor project, due to begin today before the House science committee, will involve National Aeronautics and Space Administration and Atomic Energy Commission witnesses. Industry may be called next week after NASA has evaluated mid-size April 1-on development of Rover. And Public Works engine.

Five days of hearings on the national sensor program will be held by the same committee, beginning May 7. On May 14, it will begin confirmation hearings on NASA's budget requests.

Joint Congressional Atomic Energy Committee will hold closed hearings on nuclear space projects in mid-May. Committee members already are urging faster work on reactor models and development of much larger—3 to 10 megawatt—interorbital reactor units.

Federal industry's price-fixing troubles are unlikely. Congress' disregard of advanced competitive bids on military contracts, until now levied over unratified cost-sharing Senate Judicary Committee, is giving Justice Department time to review a lot of all bids submitted to Defense Department from Jan. 1, 1958 to last June 30 on prime contracts let by the administration. Rep. Wright Patman has introduced a bill to require all federal agencies to report identical bids.

House Armed Services Investigations Subcommittee, again headed by Rep. Edward Eckert, will consider, in its congressional way, probably this month—whether to hold public hearings on General Accounting Office's charge of overpricing by McDonnell Aircraft Corp.

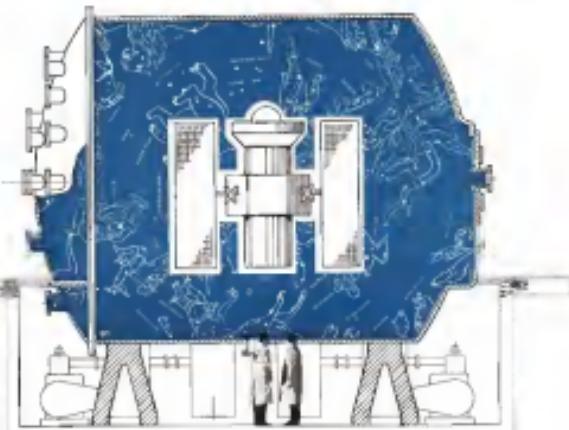
Dr. Eugenio Sanger, who with his wife Dr. Josee Brelot first proposed low-light sensitivity some similar type of aerospace vehicle as the answer for return to the crowded European continent who want to re-enter the spotlight. European countries disagree along the roads to design of large boosters.

Sanger, in this country from West Germany, for a one-week tour of missile and space facilities in the east of the State Department, believes the British Blue Streak rocket offers to the United States a favorable option; others should use specially designed upper stages either those the French Mistral rocket or the French Venera rocket. He and Germany would like the use of Australia's Woomera range for a series of projects. So far Britain has offered use of the range with as part of the Blue Streak deal.

Dr. Eugene G. Fabrikant, vice president of Allis-Chalmers Laboratories, will take the new post of Director of Applied Research in the Office of Defense Research and Engineering. He holds a Presidential Certificate of Merit for solar and missile work in World War II.

USAF formally changed the name of its proposed satellite interceptor to Husky because some religious groups objected to the previous name Star. But Air Force decided Husky's name change and spring, so Star is now called Starlight.

—Washington Staff



SATELLITE IN DRESS REHEARSAL. This 20 x 27 foot, high vacuum chamber now under construction is the newest addition to our series of chambers for complete space system development, assembly, and test at a single location. Full size spacecraft will operate in this chamber as in orbit. Satellites will be subjected to both simulated solar glare and the chill of space darkness. They will also experience launch and boost conditions, and structural and thermal loads. Career opportunities are open to better engineers and scientists to staff this expanding space laboratory.

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Rover Review

Sanger Space Views

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—Washington Staff

Global Surveillance System Study Planned

Concept calls for manned, maneuverable satellites for reconnaissance. Industry proposals requested.

Los Angeles—Air Force has asked industry to bid on studies of a global surveillance system that could lead to a series of manned, maneuverable satellites in orbit by 1966 or earlier, providing a major advance over the current Soviet reconnaissance satellite concept.

The system calls for a series of interconnected satellites that could swoop down from 300 mi polar orbits to altitudes below 100 mi for detailed reconnaissance with optical, television and radar devices. Configuration has not been specified, but the satellites might carry as many as three men. Time in orbit for one satellite probably would be about three days.

Although the projected timetable indicates that such a system could be operational by 1966, USAF believes development time could be as little as 10 years since the program is to rely primarily on existing techniques and hardware. A number of industry observers feel, however, that the timetable is extremely optimistic.

Study programs and associated initial development expected to go into how the probe technologies can best be brought forward by industry, might cost \$15 million to \$30 million. There is a strong

possibility that some special hardware will have to be developed even to complete these early phases. The proposed system currently is designated Study Requirement 158.

The Soviet system will depend entirely on a fixed orbit and from analysis of its reconnaissance information from that orbit. Later, reversible reentry probes will return the information to earth.

The global surveillance system could use photographic techniques to provide

a permanent record of objects on earth. These could be analyzed quickly aboard the satellite and studied in detail after its return to earth.

Television cameras, which would produce pictures of low quality definition than photographic cameras, could be used on as well as the satellite now for selective scanning and for transmission to ground stations. Immediate return of this information could be used to allow specific detection against known adversary targets. Other atmospheric conditions could permit use by photographic and television cameras difficult tasks could be more difficult.

Manned Space Flight Effort

SR-175 highlights the great lack of overall space flight programs now under way in the Air Force. With the exception of the X-13 rocket research aircraft, there is only the Dyna-Soar boost glider, and it will be essentially a research vehicle through its initial stage. Much of the planned U.S. effort in the field of manned space flight is confined to National Aerospace Plane. Space Administration's Manned Orbital Station, which is supported by the service.

Air Force is allowing bidders wide latitude in almost all aspects of the surveillance system. Unless development arms undertaken on a crash basis, over the configuration of the satellite would be able to draw from the experience of Douglas, Martin and possibly Dyna-Soar program.

For an operational system, heavy emphasis would have to be placed on reentry techniques that would permit a quick, bidden return to relatively unpopulated areas. The Discovery program calls for heat protection to reenter capsule later, and it could be used for development both of heatshields and techniques for a system such as SR-175.

Booster Driven

Because of the short time for which weapon systems expect to expose until late decisions to the hazardous orbital environment, at least initially, the surveillance system would make a heavy drain on large boosters.

This indicates that booster recovery would have to be considered seriously for such a system to stay within reasonable costs. USAF's Ballistic Missile Division already is going booster recovery problems close scrutiny because even the early operational Midas and Sputnik satellite networks will require replacement of any satellite that fails in its basic project.



Prototype F-1 Thrust Chamber Fired

Prototype thrust chamber for the Rockwood F-1 engine is fired at more than 2 million lb of thrust in test facility at Edwards AFB, Calif. The F-1 will power large space boosters for the National Aerospace and Space Administration. Chambers were fired at 1.59-million-lb thrust during this month (AW Feb. 20, p. 27) and has been fired more than 100 times at thrust levels from 950,000 lb to liftoff of the F-1 in the single-thrust engine regime of the thrust class being developed by the United States. Subsequent testing, using cluster of eight Rockwood F-1 engines, also develops 1.5-million-lb thrust. First future F-1 model is due for test this spring.



* AVIATION WEEK

PROBABLE TRAJECTORY of the Soviet Venus probe, shown from data released by the Soviet Union and using April 20 as the date of closest approach. Probe is shown in a solar orbit with an aphelion calculated at 95.5 million mi, and a perihelion of 49.5 million mi. Period is expected to be 280 days.

Soviet Probe Operating Normally, To Pass Within 105,000 mi. of Venus

Russian scientists and last week flew Venus probe was operating normally and will pass the surface of the planet no more than 105,000 mi. above midcourse injection corrections.

They have no basis in Soviet reports that the probe can be easily caused to change its solar orbital path although it contains a sensor to

detect and evade missile, the East German Space News Service reported.

Payload was being commanded to transmit telemetry over the days, and instruments are functioning as they were intended, the announcement announced.

The last news to hit Soviet reports that the probe can be easily caused to change its solar orbital path although it contains a sensor to

Saturn Static Test

Washington State Army at the first Saturn flight test booster will begin in the spring following four successful static firings of a Atlas general test redesign at Marshall Space Flight Center.

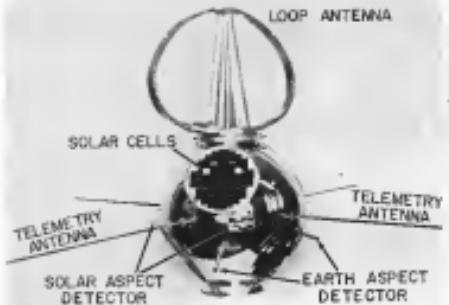
Planned test series with the final pre-flight configuration was stopped after first firing, and NASA and an additional test or two needed because all four were successful. When the program begins in December, 68 firings were planned. Test series tests did not include all eight engines and thus associated tasks and systems.

In one of the rare Soviet references to anything involving reconnaissance from satellites, Tass reported yesterday: "The following powers of conventional aerial photo equipment cannot make it possible to observe objects closer than 300 ft. at sea level from an altitude of 124,000 ft. A 240 mm photo telescope has a resolving power of 1/3 ft. from an altitude of 10,000 ft. This power is possible to observe objects as small as 1 ft. at sea level. Photo television and radio, which will make it possible to study the earth's surface and transient signs of it, will also find wide application."

Soviet Surveillance

Moreover, "considerable progress" of using satellites in space detection of objects on earth is being made. In the possibility of using photographic telescopes, N. V. Kostylev has written in Elektronika i Sistem.

In one of the rare Soviet references to anything involving reconnaissance from satellites, Tass reported yesterday: "The following powers of conventional aerial photo equipment cannot make it possible to observe objects closer than 300 ft. at sea level from an altitude of 124,000 ft. A 240 mm photo telescope has a resolving power of 1/3 ft. from an altitude of 10,000 ft. This power is possible to observe objects as small as 1 ft. at sea level. Photo television and radio, which will make it possible to study the earth's surface and transient signs of it, will also find wide application."



TRANSIT III-B low frequency radio propagation satellite (left) failed to detect from Transit III-B navigation update logic, with Loft attached when Transit went into a short elliptical orbit last week, but both were transmitting noted data.

Transit III-B Operates Despite Poor Orbit

Washington—Navy's Transit III-B as planned navigation satellite and a piggyback radio propagation satellite was providing information on all radio frequencies last week in spite of a poor orbit that will not yield lifetime from the planned three years to perhaps one-half year.

Analysis of radio signals from the geosynchronous orbit and of telemetry data on the ground showed that it was decided that the two satellites were never lost despite their final orbit, which was elliptical with a perigee altitude below sea level from each other, or they were supposed to do.

The satellites were launched at 10:45 pm EST on Feb. 21 from the Air Force Space Missile Test Center in Florida by an Air Force Ballistic Missile Division-contracted team. The Douglas Titan-Able Star vehicle was supposed to put them into a 300 km orbit, but with a 19-minutes problem in its inclination to the equator of 28.7 degrees.

But the Air Force Airborne test force, which had expert capability for raising the orbit, apparently malfunctioned, putting the satellites into an orbit with a 90-minutes period and an inclination to the equator of 28.7 degrees.

Navy had hoped that the solar cell nickel cadmium battery power system would give the Transit satellite a useful life of three years and a life in orbit of some 10 years. The low-power piggyback large horn antenna that would orbit the earth until it was an Army Map Service geodetic experiment, was to be left later in the work.

The 270-lb, 16-in spherical Transit payload carried for the first time as an experimental magnetic memory unit that would be a key part of the all-weather navigation satellite network, which Navy's Bureau of Weapons longer has been operational by sometime next year.

The satellites cover a belt stretching from the Tropic of Cancer to the Tropic of Capricorn, and can provide important information on the sun and gravitational pull of the equatorial bulge of the earth at the equator and inclined on satellite orbits.

The Loft experiments, a 57-lb, 18-in spherical sphere with an 9-in dia dipole rod attached to its surface, was to measure the intensity of very low frequency signals in the ionosphere and ionosphere, both thus measured by lighting and ionospheric 18-kc signals



from the 300-lb NBA. Naval Radio Station in the Panama Canal Zone Naval Research Laboratory facilities were located in Texas, California and Florida to receive telemetry signals from Loft and ground signals from NBA.

Loft carried instruments, omnidirectional receiver, five-channel telemetry system two VHF receivers, a power unit, two low-rate data recorders, two gyroscopes, and there is a 10-in diameter dish antenna that was to spring out from the equator of the satellite after the nose fairing was ejected. They handled telemetry and ground commands. The second consisted of a rigid, multi-turn loop an

enna, feeding one receiver and a pair of 15-ft whip antennas which were to extend in flight.

Two other Transits have been launched successfully—Transit 1B on Aug. 13 last year and Transit 1A last June 21.

Although no useful long-term information will be obtained from last week's launch of the Johns Hopkins' spokesman said that there is a "useful scientific value" in accomplishing the first injection and making an experiment and verifying the functional design." He said the "partial failure" of that would not be fully deter the operational system schedule.

Two stages with the National Aeronautics and Space Administration's Soviet Asterix and Able rockets in the third and fourth stages (see p. 10).

He said that if the Defense Department should approve the Sea Scout proposal, it could be ready within a year to place payloads of 150 kg in a 300-km orbit, and it could be launched from either the Cape Canaveral or the Kwajalein Atoll. Other plans called for launching from the South Pacific, and he said, the Sea Scout could be launched from a suborbital reentry to place orbiters into orbit.

To address to launching the Navy's proposed satellites, Alan Everett and Sea Scout also could be developed into a missile to destroy hostile orbiters. Another one to be suggested, would be to help other countries launch payloads into orbit by either the launching ship in the country involved.

La. Gen. Bernard A. Schriener, com-

wander of the Air Force's Air Research

and Development Command, told the committee that development of an unmaneuvered satellite with an automatic de-orbit system and automatic descent after the highest priority in Defense Department's space technology budget.

It is one of more than 200 proposals made study by AFRAF is in De-

fense program.

Potentially the weapon would em-

ploy a technique similar to the one the Russians used in launching their Venus probe—placing a space vehicle in orbit containing a smaller missile that is armed and ready on command.

As a defense against ICBMs, the satellite would be infrared detectors and its weapon would be armed and fired at ICBMs shortly after they were launched, which Gen. Schriener cited as a great advantage.

Gen. Theodore and Richard Mose, commanded last week by Assistant Secretary of Research and Development, stressed strength and reliability and the production of the Nike Zeus antimissile missile system to defend against ICBMs. Nike Zeus represents the ground-based missile approach to anti-ICBM defense.

Nike Zeus is the only system which can be produced and deployed within the next decade. Mose and Sieve see potential needs; the Navy has the capability of building a medium nuclear missile system—in terms of thousands of missiles—or will have it in the next fifteen, Mose added, the threat is small because it is against the type of threat that the Nike Zeus system would be effective to end.

He said the committee that communications techniques for airborne and earth applications are essentially indistinguishable from each other and that the United States cannot profit more than one national effort in the active communications satellite area.

Army, Navy Ask Congress to Halt One-Service Domination of Space

By Fred Eastman

Washington—Army and Navy, looking a bigger role in the Defense Department space efforts, have called upon Congress to act with an attack against Air Force domination of the military space program.

Concurrent with the long-standing inter-service feud over the assignment of military space and munitions to space corps during a review of research and development activities within the Defense Department before the House Committee on Science and Astronautics

by the most senior attack was launched by Lt. Gen Arthur G. Trudeau, chief of Army Research and Development. He said space is not to be considered at the exclusive territory for agencies of a particular service, but that it is a "most useful and potent new environment" to better support integrated military operations for all services.

Trudeau, noting that the existence of one or more space agencies did not mean that the services had to agree to a common program and that the implementation of such a policy is unworkable and has a high probability of being rejected.

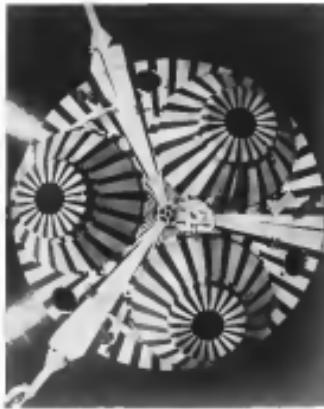
Vice Adm. John T. Howard, director of naval operations development and one of the Navy's proposed leaders under the Army's proposed one-space approach, said his ticket would be valid if the Air Force's Space Test Program was to be included in the first

Airlift Details

Washington—Defense Secretary Robert McNaul has given a further breakdown in Congress last week on overall costs of launching military airlift capabilities. He said 99 Lockheed C-141s will be bought instead of 90 by reducing C-141's cost to \$16 million. By speeding up production of the B model, USAF will get the first 90 F models in March of 1961 instead of September 1963.



TECHNICIANS celebrate the booster while it is in a horizontal position in pre-launch preparation for the second Mercury-Atlas mission. Second package (right) houses dummy reentry and life separation rockets. Rocket pack is mounted on the capsule heat shield.



Mercury-Atlas Re-entry Test Successful

By Edward H. Koloski

Washington—Near-perfect test results were shown in the second Mercury-Atlas mission, in which the pressure capsule and its reentry performed successfully under the high angle of entry loads imposed by an intentional abort at staging—the most severe set of stresses the capsule could ever have to undergo.

The MA-2 vehicle was launched from the Air Force Manned Test Center on Feb. 21. Upper stages of the Convair Atlas booster had been strengthened with two pressure and one reentry modifications. Upon end-of-service inspection, all boosters of the Mercury capsule will be rebuilt of the same parts used and will be essentially the same configuration used for Air Force Gemini and Vela payloads.

MA Performance

Performance of the modified MA system was as predicted relative to that of the MA-1 vehicle, which flew as intended 45 sec and then exploded just 17 sec after impact. The MA-2 system performance is an inherently snap-reentry at an angle of 8 to 12 deg from the orbital path.

The capsule was launched at 9:10 a.m. and impacted 10 min, 30 sec, 1,425 m downrange. It was sighted

flight path, triggered to the orbital flight path, and will be completed test of the capsule and its systems during the next few months. The capsule should return around 1.5 deg reentry. Date for launch of MA-3 depends on delivery of the last two solid Atlas boosters, scheduled for early spring.

Mercury-Atlas Schedule

Big Joe, MA-1 and MA-2 test vehicles were launched on 108-deg. reentries, and the remainder of the MA missions will be launched on maneuvers of 78 deg.

Present plan calls for MA-3 to be a repeat of MA-1 with a chimpanzee passenger; MA-4 is a three-chamber test with no staging; MA-5 is a three-chamber test with a dummy, and MA-7 and MA-8 to be three-chamber maneuver tests.

Interval between launches is expected to average about a month, and the schedule and mission depend on meeting test objectives of previous launches. A total of 14 MA launches is planned, and if MA-1 through MA-6 are successful, MA-7 through MA-14 could all be launched missions.

Intertank change in the booster configuration for the MA-1 launching was installation of an eight-inch insulation and baffle head around the upper part of the Atlas (AW Feb. 6 p. 17). Precaution changes for MA-2, which



SECOND MERCUARY-ATLAS flight was marred by weight and balance test (left) and shrike test firing of the boom-capsule configuration at the Atlantic Missile Range. Capsule was subjected to severe heat and air loads in its unshielded test flight last week.



will disengage the lower Atlas stage for all later McDonnell vehicles, are:

- Adapter ring between booster and capsule has been strengthened; cross members and struts have been added and strengthened.

- Booring has been strengthened on the filter-shaped oxygen vent valve on the top of the booster liquid oxygen tank.

Staging Abort

The MA-2 mission displayed the most dynamics which would occur in a short trip during staging, when the Atlas booster would drop off and the rest of the stage would still burn.

A light-pended extreme heating dynamic posture and loads on the capsule, but, most important, it served to verify compatibility of the Atlas and the Mercury capsule. Atlas has had little success in orbital space missions (AW Jan. 25, p. 48), but its use as Mercury booster is strongly backed by the National Aeronautics and Space Administration. NASA feels strength along the upper surface is still solar the problem and the MA-2 booster was fitted in the adapter upper surface section with thin paper thermalinsulation sheet around the interface areas to accommodate the varied wind tunnel data.

Flight sequence involved shutting down the upper engine just before liftoff, which occurred at an altitude of 107 mi. Engine power is not used in this type of short (AW Dec. 13, 1960).

Precaution changes for MA-2, which

p. 29) and was jettisoned when the orbited Atlas engine dropped. The capsule was impacted by explosives releasing the retaining clamp and igniting their separation rockets.

The capsule carried in the 114-lb. pranger, insulation was draped out

Mercury Pilot Pool

Washington—Four of three Project Mercury pilots have been chosen to train for the orbital Redstone-launched flights and two have resigned to the Advanced Manned Orbiting Laboratory.

Major G. C. John H. Glenn Jr., Major C. W. "Bill" Shepard and Air Force Capt. Virgil I. Grissom are entering the preflight training phase for the Redstone capsule which now are expected to start in April. The pilots will undergo intensive training with Redstone motors, capsules, and with launch tracking and recovery crews.

Mercury Director Robert R. Gilruth who selected the three pilots for Redstone orientation, and the choice was based on medical and technical information obtained during the 22-day training program.

He also said all three Mercury pilots are qualified for both Redstone flights and for orbital missions.

Selection of a primary team of three pilots for scheduled Mercury missions was predicted in August, Project 14 months ago (AW Dec. 18, 1960).

during the freefall period following separation, and it was separated in a 1.5-deg attitude for intrastellar firing. Separation received a signal commanding firing of the cluster retrodots as a test of the timer used to jettison the rocket package. The timer worked properly, and the package was dropped 90 sec after the simulated rocket ignition.

The capsule then went into a 1.5-deg pitch-down attitude in relation to its flight path which resulted in an 8.0 deg nose-up angle in relation to the earth's surface.

Peak Re-entry Velocity

Peak reentry load of 16 kg was detected in very brief, and total time about 10 sec was about 25 sec.

The capsule was in weighted flight 4 sec, 45 sec during its 18-min flight.

The capsule was one of the orbiters from the McDonnell Aircraft Corp production line and did not in code as impact star. Star is an orbital capsule which will carry passengers to ultimate landing shock and to act as a seat.

NASA expects that because of the passive insulation, the predicted loads will be reduced when data is released. Heating load was expected to be 25-30% higher than in a normal orbital reentry, and reentry g forces about double those on the normal reentry.

Maximum deceleration pressure, or "g," was about 900 lb per sq. in., three times the normal load.

General Precision Acts to Restrain Additional Martin Stock Purchases

New York—Martin Co., a holding company that had filed suit it by General Precision Equipment Corp., but has not yet elected to merge its assets.

General Precision had an anti-trust suit filed against it by General Precision Equipment Corp., but has not yet elected to merge its assets.

The letter stated that officers of the Martin Co. have several times, and as recently as the month of February, "stated publicly that they have no present intention to merge the two groups." This is in conflict with their private communications which have been disclosed in court.

Competition Factor

General Precision's legal move was prompted by a letter from Martin concerning appointment of George M. Barker, Martin board chairman and Clarence W. Miles, Martin general counsel and director, as Martin representatives on the General Precision board, and voting for removal of six present directors. General Precision had rejected the request.

James W. Murray, General Precision's president of Martin, said, "We have been having a stock for about two years. During this period, that company had several times publicly announced that such acquisition would only be undertaken, thereby applying no ultimate motive. The proposals and demands recently made by the Martin Co. are quite inconsistent with such statements and are evidence of an attempt to destroy the independence of General Precision and to take over control and direction of this corporation for the benefit of the Martin Co."

"In the opinion of the management and board of directors of General Precision, such a result would be extremely bad to the interest of General Precision shareholders," Murray said.

Letter to Stockholders

A letter mailed by General Precision to company stockholders and signed by Murray and D. W. Smith, chairman of the Martin Co., had demanded two seats upon the board of directors of General Precision Equipment Corp., for himself and the other for his general counsel, and the removal of six directors from the General Precision board, including five senior executives.

The General Precision board currently has 14 members.

"The board of directors of General Precision considered the demand in detail at its meeting on Feb. 14 and

both civil and military aircraft above 25,000 ft., and would be expanded to cover most of United Kingdom in 1949.

Meteorological officer, now by the Air Ministry, is studying proposals for two containing series of nuclear and gravitational weapons rocket launches from the United Kingdom, designed to study temperature, movement and composition of the upper atmosphere.

One series, with an altitude of about 37.5 mi., would be launched at the rate of one a week, while the other would be launched perhaps once a year at an altitude of about 35.5 mi.

Other activities outlined by the Meteorological Office:

- Vulcans and Victor Mk.2 jet bombers probably will remain the prime strike force of RAF's Bomber Command for the next decade.

- Handing back of the Avro Blue Steel guided stand-off bomb will begin later.

- Skybolt air-launched ballistic missiles will be bought outright and fired to Vulcans Mk.2s, using British warheads, sometime in the mid-1960s. Orders for being placed for the British-French Bloodhound Mk.I ground-to-air weapon.

- English Aircraft Corp. TSR.2 method strike aircrafts originally will go into service in the mid-1960s, probably modified to include a possible strategic capability.

- Qantas has been pleased for the English Electric Lightning Mk.3 supersonic fighter which will carry an improved air-to-air weapon believed to be a development of the de Havilland Dart.

- Transport Command, which has tried to sue during the past 10 years, will continue to build with the delivery of 16 Belfair freighters, each able to carry a 15-ton payload. Six Cessna 145s and 56 Armstrong Whitworth Argosies also will be delivered.

- Helicopter force will be expanded with the introduction of the twin rotor Belter and the first of 70 twin-engine Whirlwinds. Twin-engined version of the Westland Wessex, also is due to be placed in service.

- Expansion of Transport Command and continued reliance on married bomber force mean RAF will need express until 1970 and probably up to 1980, and is presently living a "mobil" shortage of high-speed aircraft.

- The Meteorological Corporation that Britain would continue to rely on its 51-Miles-per-second force in line with acceptance of manned satellite as an essential scientific discipline.

- Royal Air Force will, with aircraft, complement the ballistic air force, making major at Farnborough, London, while the Meteorological staff will make good progress. Royal Air Force radar already is providing a similar fac-



ARMY-1's new battlefield illumination missile is designed to tow its pyrotechnic payload. Artist's drawing depicts probable operational configuration of the missile, which is still under development at Fairchild Aircraft.

Pyrotechnic-Carrying Army Missile Is Designed to Tow Its Payload

Dover, N. J.—New Army missile now under development is designed to tow its payload, rather than push it in the conventional manner.

First test flight of the new missile is expected to take place next April. Until then, Army scientists will not know how accurate and efficient this unconventional design concept is. So far, however, the missile has performed well in all static and other tests, says the Army, and has set in motion many of the manufacturing or tooling factors for that design at first anticipated for that design.

Solid-Propelled Vehicle

The new ballistic missile is a solid-solid propellant rocket, and will be fired from a two-stage launcher. Designed for battlefield illumination, the missile carries a pyrotechnic payload in its tail which is ejected by means of a pyrotechnic switch and then falls down wind on a parabolic path. Primary reason for putting the switch ahead of the pyrotechnic is to prevent the missile from shooting down its own payload.

At the same time, however, placing an easily ignitable pyrotechnic package behind a ballistic rocket engine would render the two incompatible. The Army will not say how it solved that problem.

Illustration, the job of battlefield illumination has been carried out by

parachute flare assemblies spaced from the base of conventional artillery rounds such as 155-mm. howitzer shells. During the Korean War, the Army decided it would testbed battlefield illumination capability and wanted to achieve that without dragging whole batteries of artillerists, trucks and men from their prime mission of supplying firepower.

Optimized Systems

Pentagon Aircraft was given the job of determining how far the field of view of a missile system could be made to extend without ever a given shot at the lowest cost in manpower and dollars. And taking into consideration such things as the amount of weight a soldier would have to carry and overall logistics problems.

Among other things, the group had to work out a three-dimensional guidance pattern concerned with the number of times required per unit length of flight above ground, moments of forces, use of boost, and refueling of fueling position in maneuver.

One of the first parameters developed by the Pentagon group was the best "view" for the job. The use of the missile from the ground to the descent wheel is, in fact, the standard view. In this way, the size and weight of the payload was determined. After several brief periods, the group chose a ballistic missile as the carrier in preference to conventional artillerists. Artillery was ruled out, among other reasons because of their vulnerability to weather and landing field limitations.

Schjeldahl to Build Echo II Satellites

Washington—C. T. Schjeldahl Co. has been awarded a \$400,000, two-year contract to develop the communications satellite for the Defense Department's Project Echo. The program is to develop the communications satellite payload. Other Pentagon Agency groups involved in the program are the Concepts and Applications Laboratory, satellite design problems, and the Air Force Aerodynamics and Radar Laboratory. Satellite design is ongoing at the Lockheed and TRW Divisions of Schjeldahl. The lines for the pyrotechnic payload.

While most details of the new system are still secret, it is known that the illumination adequacy of the three-payload 800 lb. in the basal stages of artificial daylight which places a sensor above the light from a full moon in about a ground illumination of 0.25 lux at ground level.

Illustration, the job of battlefield illumination has been carried out by

Discoverer Demonstrates Orbital Restart

Wallops Island, Md.—Discoverer XX and XXI which orbited, respectively, the longer duration in orbit and the first rocket in orbit, also had the closest counterparts in the history of the series, according to an Army Ballistic Missile Division spokesman.

The two successful launches were made less than 22 hr apart. Testing was good on both of the Lockheed Argus II satellites when they climbed into orbit, especially Discoverer XXI. The 70.5-mile altitude station was able to pick up the signal from its transmitter during a power failure. The recovery was made possible by the failure of the Discoverer XXI capsule to orient the atmosphere as commanded.

The orbital period of Discoverer XXI was a measured orbital period of about 97.5 min at the end of the satellite's first orbit which increased the period of the orbit from 95.8 min to 97.5 min. The longitudinal acceleration measured the square to 97.5 min, and the period to 97.5 min shows that are unknown. Triggering the restart at the end of the test orbit eliminated any possibility of getting accurate values for the first apogee and perigee. Elevation of the single orbit will be calculated from the early tracking data.

Discoverer XXI is a repeat of Discoverer XX intended to collect data on high-altitude orbital motion of the earth. The data are to be used in the NASA analysis warning systems and being reevaluated from the results in last month's Kodak, Aldrin, Keay, Pyle, Housley, Woodward, A.R.B., Gold and New Report N-31. The planned battery life for the satellite was three days. No attempt will be made to renew a short life given by the 4.4 sec from the solar pioners. Discoverer XXI was a standard Argus II weighing 2,000 lb after all propellants were exhausted. It was launched by the last of the Block I Douglas A-3D transon developing 180,000 lb of thrust from the four Block II solid rocket boosters developing 181,000 lb thrust each.

A Block II H-3 was used to launch the heavier Discoverer XX. The weight of additional battery capacity and additional pressurized gas for the attitude stabilization system made it the heaviest of the Discoverer series at 2,450 lb. First descent was needed by the orientation powers and attitude stabilization sufficient because Discoverer XX was left in orbit for less than a day, a day longer than any previous Discoverer. The weight of the 300-lb. recovery capsule was considered. Discoverer XX had a 95.6-min period at apogee of 400 mi and a perigee of 180 mi. No further efforts will be made in reverse its capsule.

101,000 ft, when the third stage Hercules-Ballistic Booster Laboratory Attenuator ignited, and the drag and heat during its third and fourth stages was witnessed.

Third stage containing guidance package burned out 155 sec after launch, and emitted 125 sec to orbital altitude with the guidance system operating. Fourth stage continued to burn in 110 sec, and separated 579 sec after launch, and four seconds later the fourth stage Hercules-ABR Altair ignited to inject the payload into orbit.

Packard was ejected by a hollowed and inflated by nitrogen gas in an operation identical to that planned in the final Senate test, which failed in December (AVN Dec. 12, p. 37). Also in orbit is the fourth stage rocket motor, which contains a Soviet and is being tracked by the Vostok network.

Launches of 100-Nation countries tracking the sphere are Japan, The Hague, Norway, Oregon, Paris, S.M. Gobato-Fortress, Union of South Africa, Westcott, Australia, San Fernando, Spain, Tokyo, Japan, Nasa, Rio de Janeiro, Brazil, Shiraz, Iran, Corrientes, Argentina, West Indies, and Villa Delmota, Argentina.

Board Clears Pilot In Learstar Crash

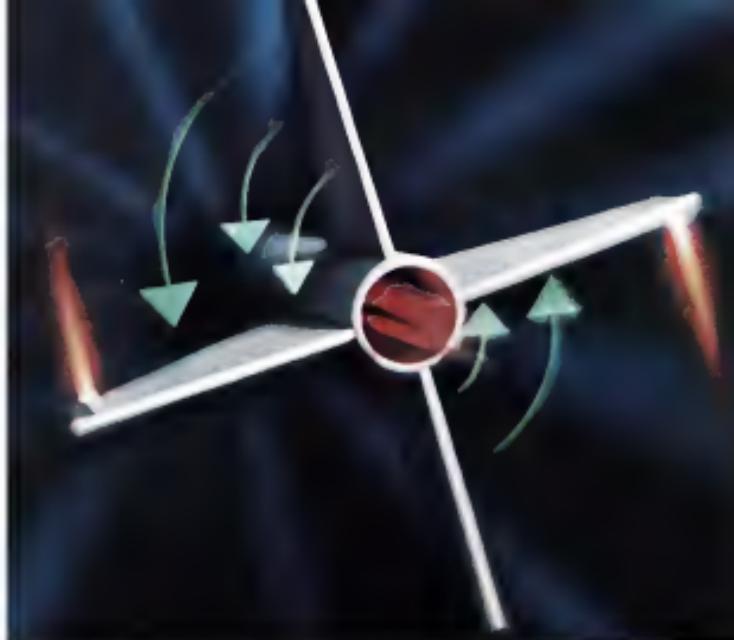
Civil Aviation Board has cleared the pilot of a Johnson & Johnson Learstar which crashed Dec. 15, 1958, and determined the probable cause was failure of attitude and altitude controller system under atmospheric conditions.

The Learstar crashed during a nonstop flight from the west coast of Woods Hole, R. I., to Atlanta for passengers and two crewmen. On Sept. 18, 1958, the Board found the probable cause was the failure of the pilot, Capt. Alvin S. Schild, 38, "to continue on to his destination in inclement weather after total power loss of one engine from induction icing."

Contributing causes, the Board concluded, were "a serious deficiency in weather briefing and inadequate weather information in the plane's flight manual for more efficient use of instrument navigation," causing him to "lose orientation in inclement weather after total power loss of one engine from induction icing."

Capt. Schild was flying in the lead of two and planned to land at Atlanta in 10 minutes, the Board found that there was no instrument approach. Infact or otherwise of the aircraft, the power plants, at equipment.

Donald W. Morris has issued a circular applicable to all Lockheed Model 104 aircraft converted to Learstar configuration, cautioning the aircraft against flying into known icing conditions until the carburetor preheat system has been modified.



Actuator controls the roll in space — *—* indicates

STEERING GEAR FOR ASTRONAUTS

Conventional aircraft control surfaces will not provide proper stops and capsids. Rollers, cables and elevators had no resistance and hence produce no reaction to their movements when there is no atmosphere. Even at altitudes only half way up, they are slightly ineffective.

The accepted answer is a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerospace Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to

1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw but they also provide for orbit change and altitude. Some of the reaction controls are white others can be operated in combination to provide the astronaut positive and flexible control.

This resistojet steering gear for space, available using ionopropulsion or high energy hydrazines, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerospace Company in the fields of rocketry, avionics and space techniques. Engineers and scientists using challenging, long-range career opportunities can find them at Bell.

BELL AEROSYSTEMS COMPANY
BUFFALO 8, N.Y.
DIVISION OF BELL AEROSPACE CORPORATION
A TELTRON COMPANY

Explorer IX Photographed in Orbit After Its Tracking Beacon Failed

Washington—Excellent photographic results from the Explorer IX satellite have reported last week in the scientific community. Although the Observation star until now that the four-bladed parabolic had failed to orbit.

Early confusion on the 12-ft. rotatable sphere resulted when the solar panel beams failed to extend and it became necessary to establish orbit by Fisher-Nova cameras and radio tracking. The satellite was launched Feb. 16 and confirmation that it had achieved orbit came the next afternoon, when it was named Explorer IX.

Launch was aimed at qualifying the solid fuel first stage. Since a static, low-level, National Aeronautics and Space Administration program had been early and last week that date submitted precise performance by the rocket.

The sphere, developed by NASA's Langley Research Center, has weight was 1.467 lb with an apogee of 1,607 mi, a perigee of 394 mi, and a period of 103.4 min. The McMurdo Hill tracking station has reported no radio observations while the sphere is fully ins-

ulated, and the scientific experiment through its orbits is being conducted with great data.

A team led by William J. Chalifour, Jr., who developed the sphere, is working on an array data stored on an orbiting computer by NASA's Goddard Space Flight Center.

Launch of Explorer IX, which was

the first launch of a satellite from Wallops Island, Va., and first time an all-solid rocket vehicle to put a payload into orbit, was the fourth of eight developmental tests planned for 1961. Development and data instrumentation had gone smoothly and backlog (AVN Feb. 27, p. 19) and two current density probe experiments were completed.

Since started the 90-day period now, Explorer IX is orbit at an altitude of 1,150 mi to 1,222 mi above Earth.

First stage Juniper, Argus, burned 42 sec and separated attached to the vehicle with ignition of the second stage Thorol-Center, 70 sec after launch from Thordol Center, 70 sec after launch at an altitude of 13,000 ft, when it was blade-separated. Second stage burned till sec, and the system cooled to



New Data Interchange System Tightens Naval Fleet Coordination The new Naval Tactical Data System will permit a task force, dispersed over a 300-mile area, to be operated by its commander with the same flexibility and tactical control he exercises over his flagship. Information from radar, sonar and other sensing sources gathered by all surface and airborne elements of the task force will be continuously displayed, providing intelligence for directing missile-launching functions, reconnaissance operations and tactical maneuvers.

Alpha is providing system engineering and management for the channelling of the intelligence data from each unit's computer and the transmitting by single bidirectional radio link to the computers in each other unit of the force. This computer-to-computer instant sharing of intelligence is the heart of NTDS.



Corporate Engineering Division of the Boeing Company • Seattle, Washington • 206/223-2000 • Corporate Sales Department • 206/223-2000

Tri-Service VTOL Calls for Advances

By Larry Booda

Washington-Industry believes the unique requirements of specialized flight and hover control systems to reduce pilot fatigue, pilot, copilot and crewed accommodations, and loading of wheeled vehicles, emergency flotation protection and maximum down wind velocity consistent with other requirements.

A variety of proposals is encouraged by the request for bids which presents wide bidder latitude in configurations, performance and powerplants.

Wide choice of engine allowable includes the Pratt & Whitney J65-P1 and RD TT11A7, General Electric J85-GE-10 and J85-GE-10 without afterburner, Pratt & Whitney J52-P6 and TT34-P1, General Electric Y161-GE-2B and Y164-GE-4-B, Allison T56-A-10W and T56-A-10, Loening T53L-7, and T53L-9.

Autostart and infrared suppression are two mandatory requirements for engine redundancy requirements. Bidders must

specify both approaches or forfeit cost or other costs to continue to conduct for informed inspection, or otherwise require us to make the vehicle less susceptible to attack by best-keeping methods unless the pipe damage. Place for storing radiation in outer containers or inner containers. All fuel tank 300 liter has to be submitted with proposal.

Lavatory information is stated as a desirable goal. However, development of this also is positive and vapor weight penalties.

The competition holds no guarantee of production or use in military operation, since the aircraft are to be built only for evaluation under operational conditions. Contract will be for a phased development program, with aircraft sufficiently equipped to provide evaluation of operational capability.

Following completion of the contractor's demonstration, agreement will be made to proceed to production. Testing will be performed by the Air Force, Navy and Army at their installations and abroad. May carriers. Contractor

Vertol Helicopter Chosen for Marines

Washington-Vertol Division of Boeing Airplane Co was chosen by the Navy to produce a high-speed assault transport helicopter for the Marine Corps.

Contract has not been negotiated but specifications for the competition indicate that the helicopter will closely resemble the Vertol 107, which has been purchased by New York City.

Original specification proposed by Navy's Bureau of Weapons limited the choice to an assault version of the twin-boiler Sikorsky HSS-2 assault helicopter but certain from redesign seems have been removed so a change that permitted the Vertol 107 type to rule the competition.

The Vertol 107 being built for the Army could not be modified because its 15,000 lb. weight and length of 51 ft. with wings folded would not permit its operation aboard Navy assault ships.

The Marine helicopter will be powered by two General Electric T44-P1 gas-turbine four-boiler engines developing 1,250 shp each. Projected mission will be post-transportation folder mission. Navy assault ships have limited deck dimensions and longer deck space necessitating the design of more compact units that accept a weight penalty.

If used Navy practice is followed, the helicopter will be designated HSSP-1. As an assault transport the Vertol will be fitted with 26 seats. Number of troops actually carried, however, will vary with the configuration selected by the customer.

For a typical 200-seat air assault operation the payload will be 7,500 lb. at a range of 400 miles at 16,490 ft.

With a reduced load load the combat radius would be extended. It is anticipated however, that an average mission would be 75 miles one way, allowing all seats to be filled.

Cruising speed will 110 kt. for most efficient fuel consumption with a top speed of 141 kt. Service ceiling will be 13,700 ft. at normal seat power and standard atmosphere. Hover ceiling and rate of climb will be 6,000 ft. Range and ceiling will be 2,200 ft. and the critical rate of climb will be 1240 fpm.

There is a ring of the size of the fuselage. Water tanks and landing gear will be located inside the hull will be sealed and have inflation spouts to prevent rupturing.

Fuelage length with rotors folded will be 44 ft. 7 in. The main rotor blades will be 8 ft. width 6 ft. 7 in. and length 24 ft. 3 in. Total volume of the cabin will be 1,014 cu. ft.

support will be required during this period.

Engineering proposals will have to state specifically cargo weight and performance which the bidder is willing to support.

Although cost proposals may be made on the basis of cost plus fixed fee, the supplier for proposals strongly emphasizes that bids made on the basis of a fixed fee or success fee you sharing will be encouraged. Fixed fee contracts are no usually to the construction business, but to the airframe and aerospace propulsion industry such a contract for a complete air weapons system would be a natural departure. Recent policy statements by the Air Force and Navy have indicated that increasing pressure toward this type of contract will be exerted.

The committee voted with the request for proposals indicating that any firm submitting requirements additional details of the competition should go to the Bureau of Weapons and not the individual services. This preselection statement is due to the fact that the final requirements were the result of compromises reached in previous discussions of a minister group (AW Nov 28 p 31).

As recently as the middle of January, the three involved research and development heads, Richard S. Mano of the Army, James H. Wiskell of the Navy, and Courtney D. Perkins, former USAF representative, had discussed their major adjustments in the requirements before final opening day. Perkins is generally credited with being the moving force behind the program.

In returning requests for proposals in the VTOL field, the Bureau of Weapons was faced with the problem that no flying qualities requirements or design data requirements exist for such aircraft. For fixed-wing aircraft, MIL-F-8754A (ASCO) applies, and for lift-craft MIL-F-8754B (ASCO) applies. These documents contain certain standard assumptions.

Before the end of the year, a new document, because methods of propulsion, lift and aircraft configuration have settled in, a pattern, Bureau of Weapons issued modifications to the existing documents as appendices. In the case of conflict between the documents, the more stringent assumption will govern.

In the flight segment, main differences shown by the appendices include:

- It must be possible to maintain smooth steady flight over a speed range of at least 30 ft/sec measured to 10 sec transition speed. The fact that transition speed is measured periodically is a rather departure from present VTOL concept, since it constitutes a forward slanting speed, a characteristic of zero-drag aircraft lift surfaces. This requirement

applies to fully powered flight as well as to partially powered flight, assuming the loss of the most critical engine.

- It must be possible to easily and safely accelerate rapidly to sustained speed and decelerate rapidly to standstill without loss of control or excessive overshoot or buffeting characteristics. It must also be possible to safely and safely stop conversion and make steep descents in landing with adequate control.

- As a mode for the conditions of flight to be investigated, flights will be made at 0, 30, 35, 40, 50, 60, 70, 80 ft on the level and at various rates of descent at partial power to at least 500 ft/sec at the most critical center of gravity position.

- In place of "colleste pitch," a term applied to helicopters, "lift control" has been substituted. The lift control must still be capable of maintaining the aircraft in the air under normal in the other. It must be carefully leveraged to keep it from overrating.

- Stability definitions have been changed to require both fixed and relative wing characteristics.

- Short takeoff and landing capabilities is defined in terms of vertical takeoff. For STOL operation, roll-over or other control must be sufficient to permit 10 deg. of rollup and to maintain straight rolls over the ground in excess of up to 35 ft.

- Roll oscillations at high speed operating rate for attaining at least a break angle of 10 deg. but not greater than 180 deg. per second.

- Design data requirements for the aircraft module requirements on maneuvering and fighter investigation programs. Rollouts must state whether government or privately-owned facilities will be used. Models for these programs must be suitable for scale model and for providing answers applicable to full size models.

Within 60 days of the award of the contract, the selected bidders will be required to submit drawings and basic parameters data sheets for a small aircraft and strength characteristics (SAC) report will be furnished to Bureau of Weapons on request, with 30 to 60-day periods allowed for their preparation.

Structural test required will not vary greatly from part practices. Control surface fatigue tests will include application of oscillations to 10 million cycles at 1.5 times the maximum maneuvering load or three times the maximum steady state flight load, whichever is more critical.

Bench tests for the main and anti-torque tail and duct-blade attachment fittings, dampers, supports, hangers, servo actuators and other rotating components will be made to substantiate 100-lb. static proof to demonstration, 100-lb. life proof to demonstration, 100-lb. life proof to first delivery and 1,000-lb. life proof to third delivery.

Within six months after initial delivery, before release for combat deployment, at least 50 hr. of flight in a single aircraft must be completed to arrive, trials at least 100 hr. of the aircraft's total flight time. Flight operations are required on a single aircraft.

British factors are taken into account and do not differ materially from those for other aircraft.

Reliability levels of each subsystem will be periodically checked and proved.

General Electric Names Apollo Subcontractors

Washington—General Electric Marine and Space Vehicle Department has selected four prime subcontractors to participate in the design and manufacture of the mainline Apollis aircraft.

General Electric, Division and Marine were awarded separate short contracts last fall (AW Dec 31 p 51). Reports on the studies are due in May.

Subcontractors named by GE are:

- Bell Aerospace Co., pitch vehicle design and liquid propulsion.

- General Corp., solid propulsion.

- Thiokol Chemical Corp., attitude control propellants.

- Lockheed Corp., avionics, fire control, thermal insulation, and communications.

- Rockwell International, aircraft and control gear, landing gear, and environmental control systems.

General Electric departments working on Defense Systems, including Heavy Military Electronics, general communications, Light Military Electronics, civil communications and guidance and control, Guidance, guidance and control, and General Engineering Laboratories, conduct plasma research.

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Defense Department Accelerates Spending

Washington—Defense Department moved full neck to accelerate military procurement and sustainment spending in line with President Kennedy's administration program.

Defense Secretary Robert S. McNamara disclosed the strictures he placed on armed forces contractors to prevent waste and unnecessary spending. These constraints, totaling \$610 million for fiscal 1967 and \$40 billion for construction firms, currently available funds and some of the accumulated spending is to be curtailed within 30 days.

Rolls Discloses New RB-153 Design Data

New details on Rolls Royce bypass engine layouts for VTOL applications show two unusual forms of the ducted fan principle to obtain both vertical lift and horizontal thrust from the same powerplant.

Most favored design is the use of a special type of high bypass proportion engine—propfan. The RB-153-1000 has been designed to direct air to the rear stage, reaction turbines, during a climb or to the front stage. In cruise the bypass flow is diverted to a separate propeller near alongside the engine.

In this arrangement it appears that the front duct-stage for providing the bypass air is entirely separate from the gas system of the propulsion engine—the low flow primary having separate, concentric intakes.

With the type of lift fan, the primary and secondary effluents from the air turbine and the ducted fan stage, have a ten to one mass ratio of the order of 600:1. Although this reflects engine increases the specific weight, it greatly enhances the bending efficiency, which is essential for a small jet. Rolls Royce has developed a method of operation to a tactical aircraft.

The RB-153, which remains unengaged as a replacement for the redesigned Boulton Paul Adonis/Messerschmitt VTOL project, is believed to be the prime source associated with the first flight arrangement.

Preliminary illustrations which will basal last week illustrate another arrangement in which the whole flow from a propfan engine is diverted through a very simple valve to a duct perpendicular to the propfan axis which terminates in a turbine driven ducted fan similar to that of the advanced 100-lb. fan.

In the propulsion engine the efflux

continues down the horizontal jet pipe and expands across another nozzle before turning a ducted fan in the last stage. The fact that the patient has now become available however, suggests that no further development of the layout is intended.

Johnson's Transport Crashes at Ranch

Dallas-Via President Randolph E. Johnson, a executive委员长, crashed his A-36 light transport plane, T-100, in a ranch near Dallas last week, killing the two pilots and after they had failed to return to Austin because of severe weather.

The Conair 246, a former American Airlines transport Johnson had equipped with weather radio, was flying to the ranch to carry the Via President to Washington. The ratings lights went out, but the crew could see them and decided to return to Austin just before crashing in the hills country 7 miles west of the town.

In another accident last week, an RAVL 500 version of the Convair 240 carrying Mrs. Under Secretary Paul B. Taylor, another member of a small Atlantic Cities N-1 import and stopped with its nose in 70 ft. of water about 10 miles off the coast of Long Island, New York, and navigation aids and couldn't land in fog at Washington D. C. After big fog at 100 ft. in landing at Dover Del., the RAVL 500 lost all electrical power and had to land at Atlantic City's Radio Field without propeller running. Both survivors was the pilot who broke his ankle.

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Airbus 501-013 turboprop engines will be installed in the United Avon Avenger, Canadair 440 assault under a \$3-million IAA contract to Airbus Division of General Motor Corp.

British Overseas Airways Corp. is negotiating its 40% interest in Ghana Airways at the request of the Ghanaian government (AW Feb 1, 1963, p. 31).

Avian Marine Resolving was almost completely guided by its current general practice of the successful sale and flight of the missile with the inserted rocket motor.

USAF-Matra T-110 I landed less than a mile from its target point last week after a 5,000-m. flight down the Atlantic Missile Range. The missile was launched after a countdown that was completed with no holds.

Mobile Army Beach Screening equipment measured on board Agusta 500 will be used as targets for Strategic Air Command bombers in 100-target low-level bombing operations. First 500 tests will go into operation next month near Miami, Fla.

News Digest

Lufthansa will buy 12 Boeing 727s with the first to be delivered in summer of 1964 and the remainder in summer of 1965 (AW Feb 6 p 40).

Richard S. Moore, director of Arms Research and Development, was promoted to the new post of assistant Arms secretary for research and development. He was serving as director of the top Air Force and NASA managers in this field.

United Aviport Corp. announced that it will change the name of its wholly owned subsidiary, United Aviport Express Corp. to United Aviport International Inc. Name change is to become effective Mar. 1.

Cabin of a TWA Boeing 707-220 was gutted last week in which body built out as the aircraft was being modified for transpolar flight of San Francisco. Damage was estimated at \$100,000. The aircraft was owned by defunct airline in the name of the cabin.

German Helicopters

Borsig-Oberfließ-Werke German Defense Ministry division or its defense helicopter units, largely for the past two years, have been delay again with the newest large flight training unit and March or possibly later for technical review.

The review committee helicopter in heavy, medium and light categories and heavy rotors around the same of whether to enter additional operation of piston helicopters or also for an all turbine fleet and, whether to have in her U.S. equipment or four blades, with which Italy has agreed to an agreement for piston helicopters development project. However, the Sud Aviation's a main partner of the SAI and Vertol 107 in the heavy category, will not be available until late 1965 or 1966.

In the medium piston helicopter range, British officials recently announced in having the Canadian agree to evaluate the Westland Wessex, essentially a Sikorsky S-58 look alike under along with the original competitor the S-58 and Vertol 107.



Westland Emphasizing Stub-Wing Belvedere 194

Westland 194, a shadow version of the Bristol Belvedere Type 182 going into squadron service with the Royal Air Force this year, is being developed as a private project by Westland. Powered by four de Havilland Gnome turboshaft engines, the Type 194 retains the Belvedere's tail configuration, and will carry 50-60 passengers. Fuselage has been lengthened to 16 ft and deepened to improve seating. The 45-ft wing span provides pitch stabilization as well as substantial sealing of the slots during cruise. Westland 194, shown as model above, is expected to be service by 1964.

anticipated rate of new business.

Western was virtually shut down and by Wednesday was handling only two flights daily. Thursday, 2,570 en planes, or 50% of its total personnel, were furloughed. Here are extracts from the letter sent by Western President Ernest D. Ballouze to C. Gifford, the National Maritime Board, and the Civil Aeronautics Board:

"Our service was strongly halted Friday night without notice... the strike against Western is stupid, irresponsible and does great damage to the public interest... the furloughs are necessary as an effort to preserve the company's funds during this period of emergency when practically no revenue is coming in... the services of all flight engineers who have refused to fly their assigned trips have been terminated.... Western is employing and training, as far as possible, pilots qualified even though they do not have their commercial pilot certificates. These en route record FAA certification. They will start to fly on regular schedules.... it is our intention to provide some service over those portions of our routes where no service exists by other air lines and gradually restore full service to all routes."

25% Pay-Cut

National, strengthed 3,400 of its 4,800 employees. Eastern Air Lines senior management staff took a 25% pay-cut for the duration of the strike. It will be too early to evaluate the full economic impact of the strike on the industry, but the effects could well be catastrophic.

In Washington, D. C., and around the country, there are efforts to either shorten their furloughs or stop furloughs over to reduce participation in that measure which might have gone to excess still in business

were going elsewhere. The national line in business will undoubtedly result in a stronger upgrading of passenger traffic for many months as the industry shows its strength. The situation is nothing but hopeful as an industry already on the level of heavy delays.

It appears at first that both TWA's and Pan American's losses will be much higher than Atlantic's schedule to a complete stand still, international carriers will either show in ranking to damage big concern or consider their small planes entirely. Northern Europe big airlines serving the North Atlantic air membership can prove reported are more serious in business.

Committee Approves Halibut Nomination

Washington-Senate Committee Committee last week announced its nomination of Joseph P. Lash to administer of the Federal Aviation Agency.

Holsch outlined these views during committee hearings on his nomination.

Airport construction. He favors a shift in emphasis at the allocation of federal aid funds to airports specifically aimed at improving air safety, leaving the financing of comfort and convenience facilities to local communities. His recommendations are now under consideration at the White House. A Rep. Reaphorn-sponsored measure authorizing \$70 million a year in federal funds for airport development "urgency" is the interests of public safety.

He also favors the right direction. In and around the airport, he said, there is a great opportunity that airports can offer to neighboring cities and towns. The present airport act, which equates \$100,000 per mile \$45 million a year in federal funds.

Locked Electra. Holsch gave the

strongly high endorsement to "locked, healthy, and relatively safe in the." He said that he piloted the Electra under conditions simulating those which led to major accidents.

"I went to Miami beyond the safe speed, through gusts up and into a sharp dive," he told the committee.

"The aircraft did not exhibit any tendency to roll. It is a configuration with foreign types. It is a natural, simple, and predictable configuration as it is very important," Holsch declared to some 40 experts under questioning by Sen. Vilmer Hartke (D-Iowa), who has been critical of the Electra.

Schedule reiterations. The civil service ceiling of \$19,000 a year for top executives, he said, could hamper FAA's aircraft development programs.

The comparable industry salary is \$45,000 a year, he said. He said that Air Force, in establishing Aerospace Corp., a non-profit organization to give technical assistance to its defense contractors, is able to keep the civil service ceiling and pay executives \$40,000 a year.

CAB Issues Order On New Subsidy Formula

Washington—Civil Aeronautics Board took as far forward as it can toward adoption of a new subsidy formula for local service airlines when it moved findings and then case, order in the Last Strike Case Subsidy Rate investigation.

Problems local service airlines have been resolved by CAB that they have noted. May 27 to file any objections they have against the order and take place (AW [no. 2, p. 29] before it is implemented, anticipated to Jan. 1.



American Airlines' first 720B, powered by Pratt & Whitney JT12B turbofan engines, takes off with leading edge flaps extended. Testflied 21st in service with American, first this airplane is the first delivered of thirteen from factory with the big engine.

First Boeing 720B Delivered to American Airlines



Four 720Bs and two 707-123Cs equipped with turbofan engines will go into service May 12 on New York to Los Angeles, New York to Chicago and Chicago-Mexico City routes. All will be designated 707-123Ps. American's recent distinction between service improved short-haul performance is permitting American to begin its first jet service to Mexico City. Besides the eight Douglas, the 720B wing leading edge is modified between nose and inboard engine to view from shore indicates.



TRIPHIBIOUS SUPPLY LINE—sea, air and land. For the Army Transportation Corps, Sikorsky's S-60 Skycrane recently lifted a Conex container from the hold of a ship at sea; minutes later placed it in a truck ashore. The S-60 can carry five tons. The next Skycrane, the turbine-powered S-64, will lift up to ten tons. Future designs will carry up to 40 tons. Loads can be carried by cargo hook, or in pods for transporting complete units such as field hospitals, communications centers or personnel.



UNITED AIRCRAFT CORPORATION
SIKORSKY AIRCRAFT DIVISION
STRATFORD, CONNECTICUT

Monroney Demands Action on Air Safety

By Robert H. Cook

Washington—Investigative arm of the nation's growing aircraft accident rate through most efficient use of existing power, equipment and organization was demanded last week by the Senate Aviation Subcommittee in hearings which probed Civil Aviation Board and Federal Aviation Agency operations in several investigations.

Chairman A. S. Mike Monroney (D-Del.) called the agency "an organization between a team of World War II Army Signal Communicators and a United Air Lines DC-3 in New York," "the margins just in airline safety," and still it spotlighted deficiencies of the present air traffic control system.

Sen. Monroney recommended the first three days of hearings on determining what safety recommendations have been made by CAB to FAA as a result of the Board's recent investigation.

Steps suggested in Sen. Monroney to improve aviation safety pending full development of more precise electronic aids and traffic procedures followed the general pattern:

- Agencies should seek authority to close airports under below minimum weather conditions.
- Airlines that fail to install needed safety aids for landings and takeoffs should be closed until meeting CAB and FAA norms.

- Radar monitoring of aircraft movement areas should be strengthened by increasing controller personnel and duties.

- Rate of traffic acceptance should be slowed over heavily congested terminals in name of greater safety margin.

- Transponder equipment, carried by roughly in a mile range for ground controllers at any one airport, should be better utilized to provide other controllers at nearby airports with a check on the aircraft's identity and position.

Safety Ramps Understated

CAB told the subcommittee that a heavy volume of accident investigation has pointed to a lack of concentrating on how to promote safety among the airlines. Lack of sufficient personnel in the Bureau of Safety, which last year logged 13,000 hr. of aviation has caused the situation, CAB said.

The problem is expected to get much worse since the Board also is charged with investigating general aviation accidents—which produced a fatality rate last year double that of the air carriers—but is "ill equipped" to do so, CAB witnesses said.

Emphasizing the need for an im-

proved staff to handle this mounting workload, Marvin Gough, chief of the safety bureau, and safety staffers alone do not give a complete picture of the Board's workload. The non-final audit of an American Airlines Electra Sept. 16 at LaGuardia Airport, and the fatal crash of an American DC-8 rater which claimed the lives of four crew members, but spared 152 passengers, of McDonnell Douglas Commercial Aircraft, Feb. 29, could have boosted the load if two planes had been landed, Gough said.

This opened the way for a series of questions on airports and terminal area accidents and prompted Sen. Monroney to observe that more than 40% of accidents happen during some phase of landing or takeoff. But no "alarm over shadowed by more spectacular accidents."

LaGuardia's lack of sufficient landing aids came under heavy fire from Monroney after CAB investigation found that the American Electra struck the top of an 8-ft. pole while attempting to "land short" on a 4,900-ft. long runway because of construction work at the airport.

The Board later recommended to FAA the resolution of a Visual Flight Rule, noting that eight might have prevented the crash had it been there last September, investigation said.

Sen. Monroney and LaGuardia is the "best notation example of failure to provide adequate safety aids" and that the Air Line Pilots Assn. has severely criticized it for this, LaGuardia reported.

He explained concern that neither CAB nor FAA had taken any action when no trust in that the equipment be installed. He urged CAB and FAA to compel "fast-tracking" local officials to install the needed aids and at the highest priority at all airports where the agency's role requires it to close airports which fail to comply with their orders.

Sen. Monroney and the agency might consider requesting authority to close airports on their own authority, perhaps to formulate a type of emergency power to deny takeoffs on an individual basis. CAB also should examine more closely the practice of allowing pilots to fly while their license airports are being considered by the Board.

The bulk of Monroney's criticisms and recommendations on air traffic control came after CAB investigation, covering the 1970 USAir accident. He noted that the United DC-8 was not given a complete radio monitoring system in marginal holding patterns "because they would slow down the entire traffic

stream."

They added that the Poston holding pattern, which the DC-8 passed at an estimated speed of 445 kt., is controlled by the Islip radar approach control radar station, which could have located the United hubster. But current operating procedures do not include an automatic radar monitoring into holding patterns when this is required by the pilot.

"It seems to us," Sen. Monroney said, "that we're in such a great need to streamline a large volume of traffic that we do less than is humanly possible to be certain that planes are in their right position. There are as crowded radar as we have time to switch for a possible overlap of a total point, even though it may mean life or death for 100 or more people."

Better Radar Control

Sen. Monroney noted that a CAB time sequence of ground instructions to the United aircraft, as compared with its high speed and distance from the radar point, showed that the pilot would have had less than one minute to locate the plane before proceeding to the assigned holding pattern.

"We should take a closer look," he determined, if radio controllers should not be given extra duties, using remote equipment, to prevent a mistake, he said. This might even be handled by having nearby controllers look over the shoulder of the radar operator until better equipment, such as those drawn up in the mobile, the senior said.

Testimony that CAB investigators who depicted the United aircraft's flight path and time sequence to Poston in a DC-8 had to use strong arm thrusts in order to make the jet turn around, that largely contributed to the accident. Sen. Monroney questioned the claim, however, and never came face of holding patterns for jet aircraft. He suggested either delivery of landings in the track, reorganized New York area or moving of some air traffic over the north Atlantic Ocean prior to landing, to avoid the danger of collision that could result from too little separation between holding patterns.

Sen. Monroney asked CAB to explore the possibility of expanding responsibility of transponder units to include both weather identification and aircraft.

Sen. Monroney also approved a CAB idea to have transponders on all aircraft operating in New York used as a "double check" for their position by both LaGuardia and Islip radar controllers.

National-Pan American Rift Widens Over Disposal of Exchanged Stock

Washington—Growing rift between National Airlines and Pan American World Airways over the disposal of stock traded in a stock exchange agreement induced further last week when National turned down Pan American's demands to re-exchange the stock.

National has told the Civil Aviation Board it plans to purchase the 400,000 shares of Pan American common stock acquired under an agreement between the two carriers. This action was taken after the Board dropped the stock exchange portion of the transaction (AWW Feb. 15, p. 39). The agreement also provided for the mutual holding of strategic aircraft, which the Board rejected.

In a letter to G. T. Burke, National's president, Robert Lewis, Pan American's executive vice president, challenged National's right to sell the stock and declared that "the only method of divestiture which has Civil Aviation Board approval is the exchange of shares."

Burke responded in a letter last week to Pan American that there is nothing in the agreement which requires that the stock be turned back. He termed it "indefensible." Pan American's slogan at the failure of the Civil Aviators Board to permit non to control the stock is a dramatic example of the new era of disunity which the greater disputes in market value between the stories of the two companies.

Potential Loss

Throughout his letter, Lewis emphasized that National was in the majority of all the benefits of the agreement while Pan American had gained no advantages. He said his company could not accept major modifications, if any were proposed, to broaden the Civil Aviators Board with a more balanced discussion of all the arguments in view of the price of National's stock at the present time.

Baker replied that National will live up to the agreement and expects Pan American to do the same. He added:

"National fully concedes that you would not for a moment attempt to usage as the argument if the market value of the National shares were in excess of the Pan American shares." He concluded by warning that if Pan American does not act to conclude its shares back, "National will proceed to sell" the stock in accordance with the provisions of the agreement and order of the CAB.

In his letter, Lewis detailed Na-

tional's plan to now default against the agreement. He said that the loss of Pan American's jet aircraft enabled National to provide jet service a full year ahead of its competitors and to be the first domestic carrier to offer such service.

Stock Price

He noted that the option to Pan American to purchase 300,000 additional shares of National stock was included in the agreement to compensate its competitor for the "indulgences loan to National and for the disparity in the values of the stock exchanged."

He said that a positive CAB opinion of the entire transaction can be obtained from the Civil Aviators Board but agreed to UN requirements before turning to the general of the relevant transaction.

Tables

Tables to help SHI the valid being left in their department, one Douglas C-124s of the Military Air Transport Service made the longest flight thus far in UN's cargo relief effort that began last summer when they ferried 110 Malayan troops and four tons of cargo to the 6,000 ft base in Singapore to Lenggaduh. With a fueling stop at Tachilek and using double flight crews to avoid delays for crew rest, total elapsed time for the flight was approximately 50 hr.

The next flight made the 8,000-ml. nonstop flight from Chiangmai to Hanoi, France, to Singapore in about 40 hr.

Eastern, Mohawk Ask To Transfer Routes

Washington-Kenora Air Lines and Mohawk Airlines have asked the Civil Aeronautics Board to transfer service to two Western cities and one New York enroute from Eastern's system to Mohawk's.

Mohawk would pick up Eastern's operating authority between New York and Buffalo and Burlington, Vt., and Albany; Glen Falls, Plattsburgh, Saratoga; Lake Little Place, Utica, and Watertown, N.Y.

Eastern couples would be given the option of transferring its other stations on Eastern's system or accepting responsible employment, at no loss of pay, to Mohawk.

The proposal would put Mohawk in the New York in Albany route pattern, allowing the carrier to compete with its services from Boston, Syracuse, Buffalo, Detroit and Cleveland. Eastern would continue to serve Montreal and Ottawa nonstop from New York and to fly between Syracuse and the Canadian points.

USAF Is Returning

Moroccan UN Troops

Washington-U.S. Air Force agents are returning the 6,000,000-tonne

tonnes of grain in the new draft pact signed. He said that the loss of Pan American's jet aircraft enabled National to provide jet service a full year ahead of its competitors and to be the first domestic carrier to offer such service.

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Eastern, Mohawk Ask To Transfer Routes

Washington-Kenora Air Lines and Mohawk Airlines have asked the Civil Aeronautics Board to transfer service to two Western cities and one New York enroute from Eastern's system to Mohawk's.

Mohawk would pick up Eastern's operating authority between New York and Buffalo and Burlington, Vt., and Albany; Glen Falls, Plattsburgh, Saratoga; Lake Little Place, Utica, and Watertown, N.Y.

Eastern couples would be given the option of transferring its other stations on Eastern's system or accepting responsible employment, at no loss of pay, to Mohawk.

The proposal would put Mohawk in the New York in Albany route pattern, allowing the carrier to compete with its services from Boston, Syracuse, Buffalo, Detroit and Cleveland. Eastern would continue to serve Montreal and Ottawa nonstop from New York and to fly between Syracuse and the Canadian points.

USAF Is Returning

Moroccan UN Troops

Washington-U.S. Air Force agents

Airline Traffic—Year, 1960

	Revenue Passengers Miles (Millions)	Revenue Passenger Miles (Millions)	Avg. Passenger Factor (%)	U. S. Mail Tons-Miles	Express Tons-Miles	Freight Tons-Miles	Vessel Revenue Tons-Miles	Overall Revenue (\$ Millions)	Overall Revenue Passenger (%)
DOMESTIC TRUNK									
American	8,161,611	8,295,741	65.3	29,484,341	12,666,337	112,324,572	F11,260,410	\$6,4	
Brussels	2,212,508	1,881,429	56.7	1,165,880	1,479,076	7,454,103	166,605,491	56.6	
Capital	5,634,621	5,077,171	22.5	5,211,909	2,376,412	12,127,242	1,192,240	56.5	
Continental	1,000,000	1,000,000	50.0	1,000,000	1,000,000	1,000,000	1,000,000	56.4	
Delta	2,333,057	1,810,220	39.9	5,875,219	2,465,016	15,681,953	160,910,915	56.3	
Eastern	7,649,563	8,161,001	29.19	4,797,380	6,161,928	21,021,022	620,211,012	56.2	
Northwest	1,881,709	1,881,491	58.8	5,848,400	7,000,318	11,645,000	1,045,200	56.1	
Southwest	1,000,000	1,000,000	50.0	1,000,000	1,000,000	1,000,000	1,000,000	56.0	
United	1,847,931	1,811,344	55.5	7,971,071	3,420,010	17,082,474	168,116,500	56.0	
Trans World	1,607,234	6,656,180	66.7	18,348,400	8,069,240	43,911,000	608,856,900	56.0	
United	7,372,814	7,381,820	44.8	16,245,200	21,415,248	27,143,900	642,947,229	56.0	
Western	1,488,000	1,488,000	47.8	5,041,437	1,199,000	4,021,370	2,020,320	55.9	
INTERNATIONAL									
American	111,181	114,103	29.9	180,918	8,441	5,889,420	14,795,912	\$8.6	
Brussels	44,413	121,176	32.9	472,284	1,105,116	14,540,410	47,474	56.7	
Caribbean Airways	367,057	37,210	43.8	38,574	84,258	3,802,380	66.1		
Delta	27,878	38,304	49.2	37,149	287,449	4,046,834	56.0		
Eastern	491,811	272,260	38.28	1,442,700	3,721,200	9,520,340	10,211,200	56.0	
Europa	1,000	1,000	50.0	1,000	1,000	1,000	1,000	56.0	
Interstate	22,832	36,829	33.5	39,844	15,241	1,056,200	6,001,881	56.0	
Northwest	108,396	231,024	49.8	121,302	186,670	71,201,240	87,710,310	56.1	
Pan American-Airlines	107,367	112,313	22.7	496,761	6,895	1,000,000	1,000,000	56.1	
Trans World	1,000,000	1,000,000	50.0	1,000,000	1,000,000	1,000,000	1,000,000	56.1	
United	1,001,831	1,416,649	48.8	2,197,647	30,273,274	106,716,020	102,100,000	56.1	
Pacific	441,073	1,264,278	29.9	16,331,103	54,574	349,447	200,400,000	56.0	
Trans World	334,504	791,202	47.8	1,007,207	5,002,000	6,002,820	18,867,270	56.0	
United	120,862	216,750	91.8	—	—	4,222,220	39,195,930	56.0	
Trans World	301,516	1,371,793	41.6	18,306,474	17,712,762	12,676,320	38,1		
United	914,354	404,723	91.7	2,457,383	119,490	1,797,260	60,842,988	56.0	
Western	10,384	10,384	48.8	500,503	292,203	9,810,327	10,384,500	56.0	
LOGISTICS SERVICE									
Airway	459,211	181,607	48.8	856,941	288,612	522,003	16,910,322	56.0	
Boeing	241,575	65,225	44.1	47,487	1,151,148	6,407,916	56.0		
Convair	144,043	33,807	39.2	304,413	47,442	1,462,293	9,455,479	56.0	
Pratt	218,519	60,935	39.8	500,403	128,074	524,000	8,110,310	56.0	
Rockwell	234,236	32,074	39.3	211,379	123,916	1,197,448	1,197,448	56.0	
Rockwell	1,251,210	1,251,210	49.4	219,318	543,378	514,774	58,261,371	56.0	
Rockwell	415,304	191,071	40.7	308,418	305,379	361,859	160,481,411	56.0	
Rockwell	449,395	116,460	43.8	316,740	317,041	1,186,448	1,186,448	56.0	
Rockwell	422,472	116,460	43.8	316,740	317,041	1,186,448	1,186,448	56.0	
Rockwell	246,647	46,704	21.7	77,024	126,459	191,200	4,722,311	56.0	
Rockwell	316,915	70,935	39.2	161,199	161,193	675,123	700,120	56.0	
Rockwell	219,077	92,388	44.2	176,422	59,774	390,357	9,364,458	56.0	
HUMANITIES									
Airbus	248,828	26,128	39.8	26,205	—	61,014	4,401,616	56.6	
Brussels	316,049	115,939	49.4	99,649	2,301,103	132,123,000	132,123,000	56.5	
CARGO LINER									
American-Red American	42,207	127,123	37.8	420,940	160,372	12,744,893	28,244,130	56.1	
Brussels-Swissair	1,351	4,019	56.8	78,109	48	6,843,341	4,188,449	56.0	
Scandinavian	207,372	158,447	45.8	8,168,370	49,493	49,493	54,449	56.0	
Swissair	18,479	116,346	52.2	416,416	416,416	26,315,423	64,510,700	56.0	
Swissair	160,273	2,037	54.4	176,395	91,054	4,341	58,100	56.0	
HELIOPOLIS AIRLINES									
Chicago Midwest	95,241	5,254	50.0	14,420	—	—	211,378	56.5	
Chicago Midwest	20,154	1,340	56.8	50,416	38,100	38,100	216,350	56.4	
Chicago Midwest	160,273	2,037	54.4	176,395	91,054	4,341	58,100	56.0	
ALASKA LINER									
Alaska Airlines	103,616	108,430	37.4	807,103	44,201	4,492,650	44,969,751	43.4	
Alaska Central	60,420	6,059	54.8	50,518	45,649	2,720,700	2,720,700	56.0	
Calif.	14,771	3,248	40.1	28,718	164,357	181,793	181,793	56.0	
El Dorado	30,208	3,000	50.7	30,749	22,333	22,333	22,333	56.0	
Seattle Airways	2,212	2,212	45.0	416	416	416	5,191	56.0	
Seattle Airways	85,193	18,309	56.7	600,080	735,166	2,146,910	24,265,910	56.0	
Pacific Northwest	120,246	116,206	49.8	1,581,156	360,644	3,910,200	16,361,263	56.0	
Reeves Airlines	16,191	14,378	44.7	4,149	—	—	2,740,000	56.0	
Western Alaska	8,079	3,775	56.8	4,149	10,322	10,322	10,322	56.0	
West Alaska	44,183	13,119	49.8	348,297	1,199,072	3,648,361	3,648,361	56.0	
Alaska Air Transport	28,703	3,258	50.4	5,379	—	—	4,314,346	346,858	57.3

*Cessna operations to Feb. 1960. **Percussa flights are charter operations only.

†Since 1/1/60. *Since 3/27/60. ©Since 3/27/60. ■Since 6/1960.

■Since 6/1960. ■Since 6/1960. ■Since 6/1960.

■Since



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From the day it went into commercial service, the Hiller 12-E had a hard start. It beat an Army-prepared H-33D survivor and an Army-prepared H-33D driver system that didn't begin to exploit its full strength.

The next step revealed the space an ideal light utility helicopter can do. Comparing on the H-33D Raven's dynamic components with a 365 hp Lycoming engine's power, light helicopter "Axis" of the test crew were bound to happen. Similar profitable operations are done every day, whenever there's an E.

That's why the 12-E has become first choice—it's the most economical helicopter possible today.

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Three Trunks Report Lower Profits in 1960

Washington—Three machine tool work reported record revenues for 1960 but a sharp rise in operating expenses forced net earnings to a level below profits reported the previous year.

Toolco's net was reported up 20% from \$10 million in 1959 to \$12 million for the year, compared with \$13.3 million for 1959.

In addition, Toolco had profit from the sale of programs and equipment totaling \$1.2 million, compared with \$2.7 million in 1959, due to lower costs from property disposals.

Western's net for 1960 crossed \$24 million, including a \$10.6-million net gain from programs disposed for the year. In 1959, Western's earnings reached an all-time high of \$3.7 million.

Western's operating revenue reached a new high of \$69 million last year, compared with \$67 million the year before.

However, the company's expense rate 21% during the year, including a 6.9% increase in depreciation charges, travel-related costs and filing equipment rentals. Total E. C. Denison's Western president said that revenues were "affected by the factory position and the business environment."

Toolco's net was based on estimated \$1.3 million of the first eight months of 1960 to write out losses of \$551,000 during the first four months and produce net earnings of \$720,000 for the year.

The year's net profit in 1959 was \$2.7 million.

Brinell's revenues climbed from \$7.47 million in 1959 to \$16.5 million in 1960, a 187% increase. However, expenses rose from \$5.9 million in 1959 to \$10.9 million last year, or rates up 21%.

Commenting on the year's activities, Cleve F. Read, Brinell's president, said:

"While costs increased across the board, one of the major items was the increased cost of operating our Technical Plants, a so-called 'spike.' We find that operating costs were boosted to 26 cents per part while the lead factor dropped 'precipitously.' We believe that the high Brinell load factor of 60.5% attained in September did not prove the higher break-even need resulting from lower speeds."

In reporting on its year's activities, Brinell made an announcement to its partners with the Technical Plants that they showed a total expense on an H-33D aircraft in 1959 to \$4.8 million net year.

Revenue for 1960 rose 13% from \$3.7 million in 1959 to a record \$4.2 million.



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Safety margins in synthetic jet lubes are being minimized by efforts to achieve lowest possible cost. This is not so when formulations are based on the Emjay® Aseries. These proven elastomers provide the considerable safety margins desired by engine manufacturers and maintenance authorities.

Elastomer clusters are such a major component in compounded lubricants, the use of existing reflect directly in improved performance in terms of rubber seal life, part durability, additive response, load carrying capacity and temperature-resistance behavior.

We are sure that your jet lube has the margin of safety provided by the Emjay Aseries. It is the only way to move.

New Technical Bulletin 4860 describes elastomer-based jet lubes available by writing Dept. Z-2A.



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Flight Propulsion

NEWS



A report sheet progress in research and products from the Flight Propulsion Division of the General Electric Company



Left to right: Lt. Col. T. H. Miller, USMC; Vice Admiral W. F. Bohm, Jr., USN; Capt. J. P. Davis, USAF.

G.E. trophy goes to F4H pilots

NEW ORLEANS, La.—The General Electric trophy for highest achievement in military aviation in 1965 has been presented to the U.S. Navy and the two pilots who set new world speed records with the Navy's McDonnell F4H Phantom II. On the award was Lt. Col. T. H. Miller, USMC, who set a new 500-kilometer record of 1250 mph, and Cmdr. J. P. Davis, USAF, who set the 1000-mile 180-km-an record.

The trophy was presented Jan. 15 at a regional Navy awards ceremony. In making the award, Lt. Col. W. Bohm, an executive of G.E.'s Large Jet Engines

Department, cited "the outstanding capability of the Naval av arm and the pilots who fly the Navy's jets."

The F4H is what Lt. Col. Miller and Capt. Davis set the closed-course records with powered by two G.E. J79-3 test engines. The Phantom II is now flying with the J79-6, an improved production engine. The more powerful -6 produces over 18,000 lb of thrust.

In 12-1 competition with Judge in making the F4H the Navy's latest high-flying, long-range fighter. For additional information on the F4H/J79, check GED-6256. See coupon.

F4H Features Unique Hydraulic Constant Speed Drive System

LITTLETON, Mass.—A unique G.E. hydraulic constant speed drive powers the variable speed propellers of the new J79 powerplants to the constant speed required by the aircraft's flight control systems. The drives, which can "lock" together to divide load, maintain system frequency constant within \pm one-tenth of a percent.

The G-E drive is a compact reduction-hydraulic transmission that links the aircraft drive gear ratio to the conventional reduced cylindrical pinions, connecting rods, and associated bearings. The simple design concept has demonstrated reliability of 99.9% per hour or over half a million operating hours in other aircraft applications.



Small belt-driven elements, key transmission components of the hydraulic system.

The General Electric F4H electrical option contains several innovations for U.S. Navy "production" aircraft, including:

- First application of an integrated drive-generator package
- First application of oil-cooled generators to provide environmental protection.
- First "high temperature" drive, operating continuously at 360°F.

For more information about constant speed drives, check GEA-6790. See coupon.

In previous tests, startup was accomplished with chemical fuel. The all-nuclear start established the feasibility of the closed-loop nuclear-turbine-combining nuclear fuel for the entire engine.

With the all-nuclear start, General Electric completed a series of Heat Transfer Reactor Experiments (HTRE) and is nearing the final part of the HTRE program, the Critical Heat Transfer Experiment. Completion of the HTRE will demonstrate the practicability of the direct-cycle cycle and resulted in the development

of many of the components necessary for nuclear flight.

General Electric is developing an advanced flight-test direct-cycle turboprop under contract to the U.S. Air Force's Air Force Research Command.

It is no longer a question of can we build a nuclear-powered aircraft

in previous studies, check GEA-7448. See coupon.



Schematic of a nuclear powerplant shows how a nuclear reactor could replace the combustion system of the familiar jet-engine/turbine jet engine.

propulsion system, but what can we do with a system in an aircraft," Mr. Davis said. "We have reached the point where we are not sure that when we do have it ready, we can build a nuclear direct-cycle engine ready to install it."

For more details on aircraft nuclear propulsion advances, check GEA-7448. See coupon.

CONVAIR 990 LOGS FIRST FLIGHT

SAN DIEGO, Calif.—The first flight of a second generation jet aircraft, Convair's 990 Coronado, was logged here on January 24 as the south California transport plane shifted on a 2-hour, 3-minute round-trip flight.

Powered by four 18,000 horsepower General Electric CJ-805-23 shaft fan engines, the 990 flew at speeds up to 500 mph and altitudes to 25,000 feet.

A medium-long range jet capable of operating from 8000-foot runways, the 990 is designed to carry 96-121 passengers. Cruising at 480 mph, it will be the world's fastest airline, and is expected to cut transcontinental nonstop flight time by as much as forty-five minutes.

The aircraft is scheduled to enter commercial service in mid-1961. In addition to speed and short-runway advantages, GEC-CJ-805-23 operators will benefit from improved specific fuel consumption and quieter engine operation.

For more information on the Convair 990/CJ-805-23 check GED-4254. See coupon.



G-E lift fan completes 90 hours' operation

VENTURELLA, Italy—General Electric recently made another important step in its lift fan flight test program, completing 90 hours of operation. Fifty hours of wind tunnel testing were included in the operation.

The lift fan will power tactical military or commercial aircraft to take off or land vertically, yet cruise as



A single CT6 powers the Sikorsky S-61, with 18 passengers aboard, at 100 mph 42-dB noise level in service for San Francisco-Dakota Helicopter Service.

Second California Airline to Offer Turbocopter Service

SAN FRANCISCO, Calif.—San Francisco-Dakota Helicopter Airlines recently announced plans to inaugurate Sikorsky S-61 turbocopter passenger service in the Bay area April 1961.

Born the new Sikorsky S-61, the Sikorsky S-61 will be offering CT6 turbine-powered passenger service. The S-61 has performed commendably in the Los Angeles area since December. The new turbocopter has demonstrated its speed by flying 10 passengers from the Los Angeles airport to Austin in 15 minutes, considerably faster than a 1-hour-and-40-minute drive.

M. P. Rogers, president of the San Francisco-Dakota line, said, "The excellent power-to-weight ratio of the CT6 engine and the proven components of

this aircraft make the S-61 the most dependable helicopter ever built." Community spokesman also commented that "its turbine engine makes it a very quiet service."

1650 horsepower and weighing only 180 lb. the CT6 weighs only 35% as much as reciprocating engine of the same size. Fifty-five inches long, it requires only 20% of the space of similarly powered reciprocating engines.

Los Angeles Airways, New York Airways, and Chicago Helicopter Airways will fly turbocopters with twin CT6 powerplants in 1961.

For more, see G-61/CT6. Information, check GED-3976A and GED-4224. See coupon.

FOR MORE INFORMATION

General Electric Company
Section K70-22
Schenectady 5 N.Y.

DGA-6800 "Comsat Space Device"

DGA-7065 "Advances in Nuclear Power Plants"

DGA-3976 & GEC-4244 "CT6"

GEC-3976A "F4H/J79"

GEC-4224 "CT6-3000 Program Report"

GEC-6166 "GE Electrical Components"

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

Phone # _____

Flight Propulsion Department

GENERAL ELECTRIC

AIRLINE OBSERVER

► Kennedy Administration is showing active interest in Civil Aeronautics Board's recent hinting of an investigation to determine whether foreign flag carriers should be required to provide U.S. air traffic and schedule information. (AW Feb. 1, p. 30). Presently, the word is that foreign governments have tried the route to White House level. Indications are that the Administration will take the position that Board orders involving foreign relations should be coordinated with the White House before any action is taken.

► Traffic trends continued to drop sharply during January, the third consecutive month of declining business. Bad weather on the East Coast during the first week of February and the flight engineers' violent strike are accelerating the steady drop in average passenger miles. In January, the domestic trunk carriers flew 2,34 million revenue passenger miles, a 3,6% decrease from the volume generated the previous January. Available seat miles were held to 9.1 billion for a share increase of 1.6% over January, 1960. Load factor for all trunklines fell 2.51 points last month to 57.7%. Except for April, 1960, load factor has shown a decline in each of the last 16 months.

► Impact of the flight engineers' strike damaged recently growing interest in airline company stocks listed on the New York Stock Exchange, including shares of United Air Lines, which was unaffected by the walkout. Last few weeks, most airline stocks had declined slightly or a slight turnover.

► More coach and first-class configurations of turboprop transports continue to be adjusted as the demand for coach seats increases. During future test sessions on North Atlantic routes, the number of first-class seats available will be held to a minimum. TWA, for example, will remove two rows of first-class seats on its Boeing 707-331 turboprop transports and add three rows of economy seats. Configuration will be changed from 182 economy and 28 first-class to 180 economy and 29 first-class, a net gain of 10 seats.

► Southwest & Western Airlines' board of directors has voted to change the carrier's corporate name to Southwest World Airlines, Inc. Resolution will be submitted for approval of stockholders at the annual meeting April 25.

► Aviation is continuing its expansion in Asia-Pacific interisland transports into scheduled service. Latest flight schedule of the 160-passenger aircraft on the 950-mile route between Manado and Kertapit in the northern Celebes, which is covered in 2.5 hr. on a daily schedule. The An-10 also is being operated as scheduled flights to Nordin, above the Arctic Circle in Siberia (AW Feb. 13, p. 52). To test effectiveness of the aircraft's improved antiicing system as scheduled operations under the most severe low-temperature conditions.

► British European Airways has strengthened its position in the eastern Mediterranean area by a recent signing of a management agreement with Cyprus Airways. BEA feels that work along with an existing maintenance and equipment sharing agreement with Olympic Airways of Greece, has advanced its competitive position in the area.

► Federal Aviation Agency will distribute a booklet to 5,000 airport managers and owners outlining preventive measures that can be taken against birds caused by birds on the ground and in the air. The report was prepared under contract to FAA by Sport Publishers and Wildlife Bureau of the Department of Interior.

► Civil Aeronautics Board deserves big well, ordering Transair Lines to drop advertising use of the DC-880 designation for its Douglas DC-8 turboprop transports in response to a Delta Air Lines complaint, may have far-reaching effects on other airline advertising programs. Most carriers can be expected to use editorial names to distinguish their aircraft from those of the same model operated by competitors. Latest example of such advertising appears in American's use of "Aerojet" to identify its turboprop-powered fleet and TWA's general use of the word "Superjet."

SHORTLINES

► British Overseas Airways Corp. plans to start twice weekly Boeing 707 transatlantic flights later April 11 between London and Newark, New Jersey, and Nassau. Bahamas Airways, a BOAC associate, will coordinate its Miami-Nassau service in concert with the new Latin flights.

► Flying Tiger Line, Seaboard & Western Airlines and Shik Airline Canada CL-44 turboprop transport aircraft evaluated earlier has been set to staff at 13,900 lb. by the Federal Aviation Agency. The aircraft is based on a conversion maintenance program.

► Iberia Air Lines of Spain will introduce Douglas DC-8 turboprop transports on April 1, 1962, in joint venture. The carrier initially will utilize one nonstop flight from New York to Madrid, followed by one weekly nonstop flight from New York to Lisbon, which will continue to Madrid. Iberia's DC-8s will seat 120 passengers in world first and economy classes.

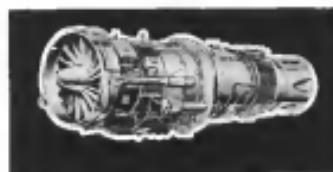
► Northwest Airlines has resumed service between Chicago and Minneapolis/St. Paul on QH700 International Airport with three daily Electra flights, preceding the first service to Chicago since the carrier's domestic flights were suspended to labor troubles which began Jan. 9. Electra flights will connect at Minneapolis/St. Paul with Douglas DC-8C turboprop transports flights from New York to the West Coast.

► National Airlines has asked the Civil Aeronautics Board for permission to suspend service at Havana until the economic and political situation there becomes more stable.

► Quantas Empire Airways will commence a sixth route, Boeing 707 package flight from Sydney to San Francisco May 2. Of the six weekly flights, two originate on the New York and Boston and one on Vancouver. All Quantas transports flights stop at Honolulu and Naha, Japan.

► United Air Lines has ordered 51 Douglas aircraft to be used in its Douglas-built Star Aviation Convair 880 turboprop transports, which are to enter service this summer, and Boeing 737 turboprop transports, due for delivery in 1963. United plans to add an altitude reporting capability to the transports as soon as FAA provides the necessary ground facilities. All of United's present turboprop transports are equipped with transponders.

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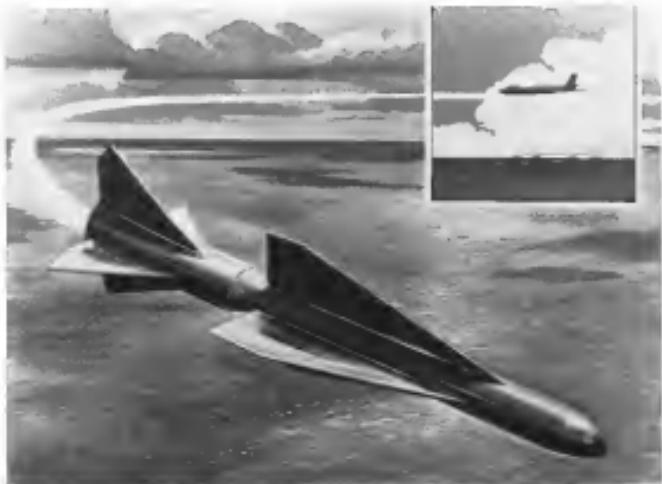
The Spey by-pass jet has been specifically designed to give the best possible operating economies for the second generation of short to medium range jet transports.

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MISSILE ENGINEERING



BENDIX EAGLE MISSILE, shown here in aerial perspective, is a missile designed for conventional targets. Overall length is between 12 and 15 ft., body diameter is 14 in. Six of these missiles will be carried under the wings of the Douglas F4D Phantom aircraft.

General Purpose Role Seen for Eagle

By David A. Andefur

ANN ARBOR, Mich.—Mitsubishi and Raytheon have joined forces to develop an improved missile system that will serve a general-purpose role rather than its original limited mission of long range targets.

The Eagle system has been designed to protect a fleet task force, envelop a battlefield, draw an inland area to destroy or support an air drop of troops or supplies. Its possible uses in attack and anti-submarine warfare scenarios is being studied as a further extension of its capabilities (AW Feb. 13, p. 20).

Eagle system development is currently at the prototype phase, under a multi-million-dollar prime contract held by Bendix Systems Division here. It was planned as a high-performance, long-range missile to be carried in a subsonic, long-endurance aircraft dubbed Missiles. Eagle system was designed

to work with the Grumman WFE HARRIER anti-aircraft aircraft, but can operate without the input from that plane.

This combination of missile and aircraft is intended to operate independently of any ground installations except those needed for flight operation of the aircraft. The missile will operate in either a carrier or land environment, and has its own electronic countermeasures equipment.

Original Plans

The Eagle system originally was intended to solve the problem of defense of a modern naval task force, spread out over hundreds of square miles of water.

But its capabilities indicated the U.S. Marine Corps, whose planners now see the Eagle as support for their concept of vertical envelopment. Proposers of the system are firm that it also is one solution to the tactical problems of break fire wars, in independence from a com-

plex ground environment and its mobility made adaptable in the form of small countries as well as large. If the complex ground environment is available—as in the Saudi situation—then a compatible digital data link, like the Eagle's, is used in with other elements in that environment to provide information.

The Eagle missile, designated AIM-N-10 by the Navy, is a single-stage weapon, saturated at 12 to 15 ft. long, and weighing about 1,200 lb. Body diameter is 14 in. Weight, weight approximates 100 lb., enough to handle a wide variety of charges.

Cross-section is cross-tailored, the rounded body has an apogee nose cone and a fixed-disk airbrake. Both lifting and control forces are generated by four light-weight, truncated delta surface arrangement of the HARRIER platform. A fixed lower canard completes the X-scheme.

Arbitrarily the Eagle missile is being designed and built by Grumman Aircraft Engineering Corp. under subcontract to

Bendix Systems Division. Grumman's work, currently funded at about \$8.4 million, includes building the Missiles wing launching racks for the Eagle and the ground handling equipment.

The two-stage solid-propellant propulsion system is being developed by Aerojet General Corp. under an \$8 million subcontract to Grumman. Rocket motor cases are being fabricated by Solar Aircraft Co. in Aerojet subcontract.

Complete Eagle guidance system is split into several major development contracts. Westinghouse Air Arm Division is building the airborne radar in both the Missiles and the Eagle aircraft. The target from these radars, plus other information, is handled by an airborne tactical computer being developed by Litton Systems, Inc.

Radar and maneuverability guidance is the responsibility of Bendix Research Laboratories Division. Terrain guidance is a Sanders Associates, Inc., development, believed to be a efficient pulse-Doppler radar type with extremely high target resolution.

Some of the subsystems are being designed by Bendix Pacific Division, where initial production, assembly and test responsibility will also be assigned. Eagle's auxiliary power unit will be built by Allis-Chalmers Manufacturing Co. Because of constraints will be Denoyer & Associates.

One indicator of performance is given by the requirements for test range instrumentation which will be required to monitor altitudes up to 100,000 ft. and speeds up to Mach 4. Missile range is on the order of 100 nautical mi.

Missiles Concept

Carry and launching assist for the Eagle system is the Douglas F4D Missiles, a two-seat, turboprop, subsonic aircraft capable of low to six-hour endurance. Although the concept of the Missiles developed in parallel with that of the Eagle, experience for the type could also be correlated with existing knowledge from development of the HARRIER, and low cost on Eagle to deliver an end-game weight, sleekness, and maneuverability.

For this reason, Missiles proposals were not received by the Navy until 1969, with a due date for submission of designs of Feb. 29, 1970. Six companies bid on the Navy's Airborne Weapon System (AWS) Boeing Wichita, Christie Vought, Douglas, Grumman, McDonnell and North American. Douglas was chosen by the Navy's evaluation group and the company started design of the missile aircraft.

Missiles is built around a three-axis gyro pitch, yaw, roll, and missile control operator. The missile system works in its own environment, in a parallel mode with that of the solar operator in

an ASW helicopter. The task of the operator is to hold each a direct control device derived from any plane of airplane operation. Thus pilot is in control of the missile.

One indicator of the independence of the missile from airplane problem is in the assignment of negative responsibility for human factors work on the operator and his instruments. In the Missiles aircraft, such work is part of Missiles System task. Douglas, although designer of the aircraft, is only responsible for human factors or the pilot instrumentation.

Douglas Missiles is a conventional aircraft, powered by a pair of Pratt & Whitney T38A-8-2 turbofan engines rated at about 17,000 lb. thrust each. Top speed is subsonic, entered at Mach 0.9. It is designed to cause fear to the target because of the aircraft's high target resolution.

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Autonetics Guidance Programs Minuteman

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speed, carrying a primary armament of six Eagle missiles.

Current status of the Missiles program is an active one, even though procurement funds have been cut from the fiscal year's budget (AW Feb. 13, p. 31). Donald W. Douglas, Jr., and recently that he was optimistic about restoration of production funds for the airplane, which was well into the development phase.

Douglas and other companies in the Missiles competition selected both new and modified aircraft as launching aircraft. New aircraft might include a modified version of the Eagle aircraft, or a modified supertanker was specified as one out of a dozen or so aircraft of the program.

Navy has taken some Douglas A3D twin-turbine aircraft to Bendix for development and flight test of



Autonetics Guidance Programs Minuteman

Mobile test of Minuteman, installed from Cape Canaveral Feb. 1 (AW Feb. 6, p. 20) shows Autonetics guidance and control system steering to program the missile, about 3 sec after launch, at approximately 500 ft altitude in an angle of about 20 deg.



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Eagle system components. These plans, although unreasonably large for the Minotaur craft, could be modified so the launching craft at the Navy were not able to afford Minotaur as a separate aircraft placement program.

Besides, he has received three contracts amounting to \$50 million. First was with the North American and Douglas companies for the development of the aircraft carrier launching system. Second contract was awarded April 17 for \$25 million, and the third follows last November to the amount of \$26 million. Out of these new sums funds for the placeholders, such as the \$8.5 million to Grumman for the surface.

One indication of the amount of money involved is a Navy estimate that the final cost of the program will be about 75% chargeable to guidance and control, 10% to powerplant, and 15% to hardware.

Maxline funds are separate from the Eagle budget; no production funds have yet been earmarked for the plane, but it has been factored well along into the developmental stage.

Key Features

Studies of the increasing complexity of intercept problems in the 1950s showed that higher speeds of intercept were imposing heavier requirements on the design of the remainder of the in-trip systems. Reduced travel time or aplasia, one consequence for increased performance, meant that radar data rates were substantially reduced. Closing speed between intercept and target gave a pilot less time to complete closing than was in the fire-control systems then available.

In 1993, these writers had become so convinced that the Navy started a series of formal studies of the entrepreneurship problem and all the ways it could be solved. These studies were the genesis of the Eagle concept.

Bell Telephone Laboratories, acting as consultants to the Navy's Bureau of Aeronautics, suggested the approach. Bell had been government contractor to the service since 1917, and was in the direction and control of the heavier aircraft. That year one could build an airborne launching site, with as many as sixteen aircraft in formation and identification of target, prediction of target flight paths, launching at optimum times, initial and mid-course guidance, and radio communication with other things. The launching site could be carried in a slow flying airplane built for comfort and not for speed.

Navy picked up the concept and developed it further with its own study program at various installations during the next two years; the more Navy studied the problem, the better the Eagle shot looked. There was natural



Pershing Missile With Group II Nose Cone

Asym-Motus Feeding Test. The field module is shown with an Group II zone zone used in the last test (AW Jun 2, p. 13). Penrhyn has had more completely successful test flights in L1 day and night launching attempts. The 1411 module is on the Tapio Group

opposition from some naval pilots, who came out with strong negative opinions on the whole idea of automated intercepts. On the other side of the argument was a valid point from the Navy's communications officers and engineers, and eventually their weight carried the issue.

There was concern in the early stages of the Eagle project that it would duplicate the U.S. Air Force's F-105 long range interceptor project, then in design at North American Aviation. An evaluation of both projects by a neutral committee headed by National Advisory Committee for Aeronautics' John Stack, concluded there was no duplication of effort, and that Eagle was justified as a separate development.

Final operational characteristics were weighed out by the Navy for a 1968 design competition, which specified that a complete systems design be submitted, not just a proposal with details to be worked out later. There was only

Major E. H. Hart

One major effort on Eagle is going into a cost-reduction program which began at the top level in Boeing Systems Division and extends out through all phases of the program work at subcontractor levels. Value engineering and value analysis techniques are used to monitor running development costs; subcontractors are expected to use similar approaches to keep their costs down.

Every six months, Bausch engineers review "subsequent" specifications, looking for places to reduce costs. Requirements are rethought to determine whether they are realistic. Requirements are questioned, also, because one way to cut the cost of new development programs is to refine the amount of system support, generally, available at every working and managing level.

This facility is another one where no changes have been made. The two



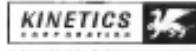
Kinetics 100-pole, double-throw,
15-amp switch occupies only 45 cu. in.



This rugged, dependable electric motor drives the generator in the new Electro 16-pole, 4000-volt, 110-cu-in. switchgear, reliable equipment under extreme vibration and acceleration, as required.

For space-critical and reliable applications, Kinetek Corporation has developed a new switch that combines maximum reliability with extremely high density construction for the most circuits in the least space. The 180-pole, double-throw switch measures only 5.2" x 1.6" x 2.6", has switch contact ratings from 1 ampere to 15 amperes, continuously. The open switch accommodates 2.15

The Kinetronics switch can make discrete or simultaneous reliability. There are no permanent magnets or springs, no linking devices, or other parts that are prone to wear and/or need repair. The switch can be transferred at 42 G's, 2000 cycles. Once it's been triggered, no power is required to hold it in position, saving batteries. The switch contacts are conductive elastomer over the whole transition spectrum, from 5 to 2000 cycles, at 40 G's. Voltage drop across contacts is less than



Hercules Casino

Casing for the USAF Hirode third stage for Marauder is produced by washing glass fibers to reinforce the nose plasma cone. Light-weight, biodegradable, case is made at Herkut Products Co's Rockville Hill, N.J. plant.

done in the past has been to build a test facility for some purpose and then either pack it up or salvage it at the completion of the test routine. Often these pieces of equipment are never scheduled into the flow charts of a project, so that dephasing is frequent and therefore expensive.

Borden has treated these items by scheduling whenever possible, and has shown savings by shipping a piece of test equipment around a plant where it can perform the same kind of work in different locations.

Navy wrote the contract on the basis of defining the end objectives of the total Eagle program, and covered the project from initial design through production and operational use with the fleet. The program provides for money for the total program, although funding is on an annual basis.

There are operational changes that would prevent combat changes to match changes in earlier systems techniques or the enemy threat. The intent of the Navy was not to be down the project too far, but to arrange a program that could be flexible enough to reflect the state of the art.

Changes in the nature or amplitude of the expected energy threat, developments in the short-wavelength of electronic countermeasures, major advances in propaganda systems or new techniques of guidance can all be fed into such diagnostic

Changes of this kind are bound to occur as the test logic during any weapons system development even those tested through in a cash program. But Eagle's pass it down.



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Performance characteristics have been considered to provide accuracies of $\pm 0.5\%$ error band in most ranges. The probe can be readily adapted to accommodate a wide range of exotic fluids.

For example, since on the Web site and its companion, how past influential work, see the *Journal of S&S* and

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This is systems capability at NAA-Columbus

Assembled at the Columbus Division of North American Aviation are the facilities and the proven technical intellect to bring original concepts swiftly to practical production by the most economical and efficient methods. Here, in one of the most complete centers of advanced systems technology in the world, many of the important advances in electronic, electromechanical, and environment systems, as well as other areas, have been made. This is true systems capability ... this is the Columbus Division.

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"A" TEAM. Columbus developed unique "A" seat to study posture tolerance to a high degree of vertical acceleration, and to make known factors to the machine. Advanced low-level high-speed ejection systems and pilot response in these flight regimes will be studied with it.



NATO NIKE ELEMENTS. An advanced type of antenna, constructed to much precise tolerances so that it will be tuned to exact pitch, will be built by NAA-Columbus for the Air Force on "Hoyteck Hill" near Tyngsboro, Mass. Unique designs developed at Columbus allow the rigid specifications to be met with significant reductions in dead weight, and in current power requirements.

program. The total span of the whole program, beginning with the first funding of design studies, is estimated at 18 years, with a total expenditure of \$1.4 billion, including procurement of the Missiles.

With the present status of the Missile still uncertain, these cost estimates may be revised if alternate plans to use modified aircraft go through. But either way, this mobilization dollar program is being planned to give the Navy a unique weapon, capable of performing missions that can not be done by any other division of defense forces, and capable of flexibility and versatility in handling a wide range of missions. As such, the program represents a new approach to the development and use of missile systems.

Army, Canada Join In Anti-ICBM Study

Washington—Canadian Department Research and Development establishment (CARDE) has joined the Army Ballistic and Guided Missile Agency in an investigation of ballistic missile defense policies and techniques.

Designed primarily to aid development of elements of the Army-NATO Zone sub-strategic missile system, the exchange will make nuclear warheads available to the United States for tests at model ballistic missile defense sites.

CARDE, an element of the Canadian Defense Board, is charged with providing advice and research on weapons systems.

CARDE is concerned primarily with aerospace related studies and programs.

In the CARDE test facility, warheads weighing up to 100 lbs are fired at high speed from parabolic guns up to 14 m in diameter, permitting studies of reentry vehicles, the detecting and tracking incoming ballistic missiles.

NATO Nike Elements Organized Along Rhine

France-Duits and French anti-aircraft missile battalions are moving into position in the Rhine area to join American and West German units in the formation of a "Nike belt" to be built along the North Atlantic Treaty Organization's first line of defense.

Total of 32 Nike battalions, three of them German, will form the "belt." Missiles involved in the established part of the "Nike belt" include both the older Ajax and the more advanced Hercules.



Titan-coated shrouded nozzle is shown during test. Flexadur propellant and its motor has high tensile resistance, a factor that aids model rocket site testing. Left is cutting bell in background. With model reversed (right), machined pattern of crater cavity in propellant grain is visible. Smooth finish and absence of roughness or cutting when propellant was cut to model is evident.

Flexadyne-Propelled Rocket Engine Fired at -75F

McGregor, Tex.—A 31-in.-dia azimuth rocket engine, containing some 3,500 lb. of Flexadur solid propellant, has been fired successfully at -75F for the last time. Officials of North American Aviation's Rockford/Solid Propulsion Operations here say that they believe that this test represents the longest solid propellant rocket motor to be cycled and fired at such low temperatures. Thrust rating was approximately 10,000 lb. Motor was made and tested under a USAF research contract. Prior to test firing, the azimuth-housed Flexadur motor went through two complete temperature cycling from -75F to 175F. X-ray photographs prior to and shortly after ignition of azimuth cracking in segments of propellant from its core. Significance of this, according to Vice President T. E. Myers, is that it provides important advantages for boosted missiles, permitting operational reliability

without need for special heating or handling equipment. Solid propellant propulsive capabilities are superior to aerosol propellants because of the relative thickness of the propellant web in the motor. Web location of more than 10% webbers not stability of Flexadur, the very long solid rocket motor—such as the one in the two-dimensional thrust class. Rockford/Solid Propulsion Operations engineers, prior to the 31-in.-dia motor test, successfully fired 11-in.-dia motors with Flexadyne propellant at -75F. These test specimens had been cycled five times between the -75F to 275F temperature range. The 31-in.-dia test specimen showed no evidence of cracking. Flexadur propellant (AW Aug. 8, p. 50) is based on an advanced polybutadiene fuel binder and features high resistance to cracking, thus



Technician weighs loaded motor to determine load quantity of propellant. Exact weight, plus other known parameters of propellant burning characteristics and grain design, make it possible to predict performance of rocket motor. Motor is blank from cutting bell in preparation for research to cold cell (right). Heavy bell one was manufactured of T-1 steel. Nozzle had high temperature alloy throat insert and was plasma-coated with tungsten to protect it from over 5,000 deg. flame temperature.



After two complete temperature cycles, from 175F down to -75F, motor was inverted at -75F with two narrow-cut radiation cooling. Technicians found no evidence of propellant cracking or pulling away from case loading. An hot conditioning step prior to firing nozzle and forward load was attached to motor and seat was given final drilling in -75F (right). Each complete cycle takes 175F to -75F and return took approximately two weeks. Blank, heat-coated motor is removed from cold cell chamber.



Chilled motor containing some 3,500 lb. of propellant, is moved immediately by mobile truck to test stand itself. Engine was left in nozzle sprays during cycling to keep mixture from propellant. Motor is held down in test stand (right) and spacers installed to prepare for fire (below). Heavy-duty blower was used to hold motor at -75F during move from cold cell to fire stand. Thermocouples for measuring case temperature run in insulated cans are visible around off-end.

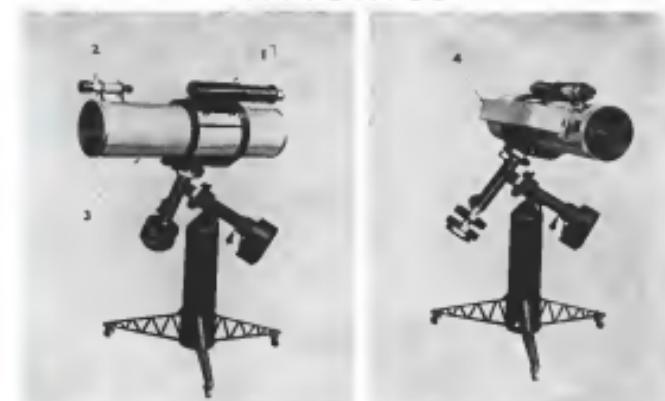


This gigantic GCR-proposed solid propellant booster is made up of easy-to-haul segments that simply would be bolted together at launch site. It could put a 280,000-pound space station in orbit—or send a 60,000-pound manned spacecraft to the moon. It can be developed, built, tested, assembled, maintained, and operated for a small fraction of the cost of a comparable liquid system—yet it is much more reliable. It can be operational by 1967—if we start now. Smaller solid boosters—able to orbit 50,000 pounds—can be available by 1964. **GRAND CENTRAL ROCKET COMPANY**
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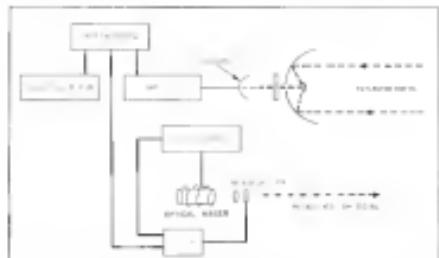
EXPERIMENTAL coherent optical radar (left), which is operating successfully at Hughes Aircraft Co., employs pulsed ruby optical master oscillator (2) attached to side of telescope receiver (1). In modified version of same radar, lighting source (4) is at rear of receiver. Calculations by company's scientists indicate that first experimental models will range several hundred miles in space where atmospheric absorption and scattering of light are negligible. Second view (right) shows laser oscillator and associated electronics (4) are mounted to telescope

Hughes Develops Coherent Optical Radar

By Barry Miller

CALIFORNIA CITY, Calif.—Experimental models of coherent optical radar systems with unusually high angular resolution have been operated recently by Hughes Aircraft Co. scientists only nine months after another company scientist solved the basic technological advance which made them feasible.

The new model, which Hughes calls Calidar, an acronym for Coherent Light Detection and Ranging, has been put into operation during the early summer of the first orbital season (AW, July 18, p. 90). It is the coherent optical radar of red light generated by the master which forms the base signal of the new radar and is the source of its principal potential advantage—exceptionally high angular resolution. This high angular resolution—a measure of a radar's ability to isolate a single target within a cluster of closely spaced targets—probably will make Calidar extremely attractive to military services far out in space. For it is outside the earth's atmosphere where light waves are not



COHERENT optical radar system, called Calidar (Coherent Light Detection and Ranging), employs ruby optical lasers as transmitters. Light pulses are collected by lens, transmitted toward and then reflected toward distant target. Returns are collected by mirror system in telescope, detected and then processed conventionally. Because of narrow beams of even fast-pulsing optical lasers, system provides two orders of magnitude improvement in angular resolution over present radars. First experimental system here used off defense targets about three miles during clear, daylight conditions.



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The Control Automatic Monitoring Console monitors the status of the active site and displays equipment degradation prior to failure.



The Checkout Data Processor processes data collected directly from and transmitted by the BMEWS equipment to the simulator.



The Automatic Excusing Console displays design data and the location of degraded equipment.

RCA Checkout and Automatic Monitoring (CAM) equipment has greatly enhanced the reliability of complex ground measurement systems. Acceptable for use in system study purposes, and as an integration tool for systems currently being implemented, CAM equipment is available for all complex commercial, industry, and government systems. For a description of the RCA Checkout and Automatic Monitoring Equipment, write to: RCA Major Defense Systems Defense Electronic Products, CAM-127-304, Princeton, New Jersey.



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Prime Contractor: Western Electric. Missile: Douglas.
Booster Motors Propulsion Contractor: Thiokol.

THIOKOL

Thiokol CHEMICAL CORPORATION, BRISTOL, PENNSYLVANIA

Rocket Operations Center Ogden, Utah

Nike-Zeus Motors produced at the Redstone Division

subject in absorption or scattering that optical sensors become incapable with conventional side plates.

At present, however, the Hughes optical radar development is in its infancy. Some of its components are large, the enclosed parts characteristic of such experimental work. The entire unit must fit inside over 100 extremely short distances [5 mil.]. Yet its operation demands the rigidity of coherent optical equipment at high off-axis, angles during direct light exposure.

The potential which promises of optical radars predicted for coherent light radar before it was a reality (AWW Dec. 14, 1958, p. 82) may soon emerge due to the optical sensor's ability to generate a sharp coherent beam of single wavelength (10 million lines at single-colored sunlight), the beam width of the experimental system—a direct function of a radar's angular resolution—two orders of magnitude better than that of current operational radars, according to Hughes. Ultimately, these optical benchmarks should be made even better (over several years) with the use of better quality ruby crystals in the laser.

To get the same narrow beam effect with an X-band radar would require a prohibitively large dish, points out Dr. Malvina Stahl, who leads the Cobalt development team at the Engineering Division.

Earlier Experiments

The idea of optical radar is not new. Several optical radars have been proposed, built and used for short range applications in the past, since World War II. But these systems and coherent light sources—such as carbon arcs or other discharge sources—lacked gain in a narrow beam light source at adequate power levels. To obtain the narrow beam effect comparable to that provided by optical radars, a reflector must be employed to concentrate the wave. To match the user's interests, the coherent source must be installed in a case that requires larger sections to achieve a narrow beam effect.

Two experimental Cobalt systems depict double-side signal-to-noise ratios, as shown in an accompanying photo graph of a dual-gage oscilloscope recording of Cobalt pulse train (p. 61).

An analysis in a block diagram of the complete radar system for the Hughes optical radar consists of a ruby optical source which mixes in the transmitter and a slightly more complicated ruby vapor-mirror-electron combination. The transmitter is attached to the end of the telescope.

Because the ruby optical source does not generate a narrow beam as theoretically possible due to superluminescence and vapor-gas breakdown of chlorine impurity atoms through the opti-

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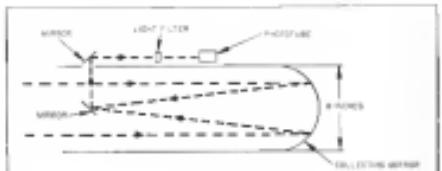
whatever a liquid's state or attitude, whether still or in agitation, the volume indication is the same with the Liquidometer Matrix Liquid Quantity Gauge. A capacitor type measuring probe - interdigitate in construction - is the heart of the system. In addition to actuating an indicator, output can be telemetered, used for control purposes, or fed into computers. Potential applications: measuring liquid oxygen for extravehicular; gauging liquids in advanced rocket propulsion systems; all-altitude gauging of aircraft fuels. Technical details in Booklet 694.

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REFLECTED LIGHT SIGNALS of optical relay in development at Hughes Aircraft are reflected by mirror at the one end of a telescope focused back into a second mirror and then reflected by a third mirror through a light filter into photocells. Signals are then amplified, processed and displayed in remainder of receiver.

At a low setting it is employed to further calibrate the beam. Broadly, if the receiver output signal is too high, it can be doubled, the receiver gain, when a 64-ampere filter replaces a 60-ampere one now being used in the receiver.

Actually, the major development is the result of two parallel and similar efforts, the one under Dr. Stritch here and another, directed by Dr. George Smith at the company's research laboratories in Malibu. Both programs are progressing at about the same pace with the results of one group being duplicated in the other on a day-by-day basis, according to Dr. Rex C. Mack, who is coordinating optical relay services at Hughes. Dr. Stritch and his colleagues plan to present a report on their work at next month's meeting of Radio Engineers convention in New York.

Image adjustments in the equipment aimed at improving its operation. The receiver's 300-ampere capability can be doubled, the receiver gain when a 64-ampere filter replaces a 60-ampere one now being used in the receiver.

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Pulse Control

One central feature of the system is the manner in which the shape of the pulse which excites the wave is controlled.

A pulser, shown in the system block diagram, controls the basic pulse.

A high voltage power supply, feeding a delay line in parallel with an antenna and in series with a bias tube, controls the control.

When the trigger is fired, the delay line discharges through the bias tube, creating a self-limited short-pulse pulse.

It is fed early so the center of power pulse remains at the waveguide feed point.

The waveguide feed point is the point where the wave is reflected from the waveguide.

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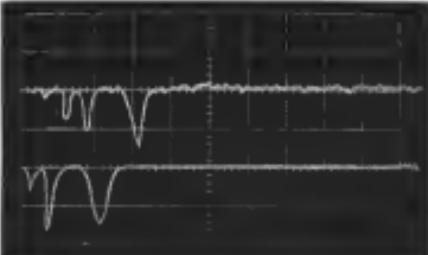
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PULSE (bottom) and current (top) by Hughes experimental coherent optical filter are shown in Tektronix photo of dual-channel oscilloscope traces. Both traces were triggered by the first pulse of a set of three given. Top trace is followed about 1,000 ft. from the rate at company's plant in Culver City, Calif. Oscillations sweep speed is set at 2 microseconds per sec. Photo was retouched by Arthur Work to draw the reproduction.

filter eventually will give way to a one-cavity unit.

* Better extraction of crystal-loaded methods of exciting the crystal will increase rejection rates.

* Attenuation and backscatter reduction of light waves in the atmosphere and even the backscatter of the fluorescence of the rate and its atmosphere are imposing limits on the use of optical filters in terrestrial applications. In fact, Dr. Mack indicates, Culver can probably only be used effectively in space where atmospheric problems are absent.

Because of the very narrow beam required, a target is difficult and might require repositioning to other cameras. Yet the cameras would be all-line capable, thus requiring generation of a frequency domain similar to that of Color-TV and an 8-line image with it.

Development of optical filters marks the first atomic application for which

beam splitter optics are being used. This is a new technique in the optics field, and it is believed that the filters will be used in the future to reduce noise and improve resolution.

In space applications, the Culver

high-gated optical filter is well suited. The continuous-wave laser, whose operation was demonstrated recently by Bell Telephone Laboratories, has the appearance of being more promising in communications.

It is not surprising that Hughes, which jumped on to the bandwagon with the optical filter, the first optical filter manufacturer, would attempt to seize a leading position in the application of optical filters to systems in the field of radio where it has considerable design and manufacturing experience.

Sampling of Sonobuoys To Receive Sea Tests

New York-Simple lots of six sonobuoys for Navy anti-submarine warfare (ASW) aircraft will be tested under operational conditions in the ocean area off Principal Point, Md. Initial produced quantities are scheduled to first year.

Vacuum Co. of America, Inc., Old Saybrook, Conn., will run the test program for the Bureau of Naval Weapons and will determine performance and reliability of sonobuoys made by various manufacturers. Sonobuoys under test will be dropped into the ocean 10 miles offshore of Principal Point by a Navy P2V and compared with a test mission, dropped several hours earlier and shadowed out against 16.0 slugs sonobuoys, for acoustic threshold frequency, and boom response and power. Motor tests, which can result from a ground station, focus sets varying frequencies and voltages to simulate submarine



Electroluminescent Cockpit Indicator Displays Engine Data

Electroluminescent cockpit indicator which provides constant readings of aircraft engine speed and fuel consumption rate was developed by Lear Solid State Parts Laboratory and delivered to contracting agency, Naval Air Development Center, Johnsville, Pa. Each of these indicators consists of a 100-electroluminescent strips. Successive strips illuminate when reading equal corresponding to power being removed charge has an RF modulator, which then allows degree of variation in new tube. The 16-foot electroluminescent engine output causes electroluminescent strip to light. Use of electroluminescent and photoluminescent phosphors now make more reliable smaller and lower power indicators possible. Lear now has several plane models of \$395,000 to develop two-dimensional (x and y) indicators for Air Development Center.



HONEYWELL has cut size and weight of its standard fuel gauge assembly (left) in new experimental model (right) through use of plastic microelectronic construction techniques. Micro-Electronics strain-gauge amplifier, built by Honeywell on glass substrate, is used in 8.5% zero-gravity model, replacing conventional amplifiers directly connected.



Honeywell Expands Micro-Electronics

By Philip J. Klass

Minneapolis-Minneapolis-Honeywell this year will double the size of its company-financed program in microelectronics and teletronics, a broad-gauge effort intended both to apply available techniques to today's hardware and to develop the more advanced techniques required for the coming decade.

The company has budgeted approximately \$750,000 for the current year, roughly twice the annual budget last year. Much of the work will be done internally, and that this research policy which a long time ago might have been considered for less expensive by a company like Honeywell.

The company already is applying deposited interconnection techniques, both in substrate and in extrusions which the Aeromatic Division is delivering. For example, Honeywell has produced a number of ranges of aircraft fuel control systems for the Convair B-58 which uses a four-stage downflow transister amplifier where junction and connections are produced by vacuum deposition.

Honeywell's program is being carried on in three divisions: Aeromatic, Semiconductor and Research. It is being developed along three different paths in regard to aircraft: one is to find parts and subassemblies around 1965-67. Techniques and knowledge coming out of the research in this firm, solid-state

elements and materials, anticipated by differences in technologies and unanticipated availability of materials.

* **Type I:** Use of conventional passive components, including resistors, capacitors and diodes, with conventional analog-to-digital converter and digital logic. This effort, pursued by Honeywell's Aeromatic Division, aims at immediate application of existing techniques and improvements in these techniques.

* **Type II:** Solid-state circuits in which solid-state functions are applied to flight control systems. Much of the work is being done in integrated circuitry and thin-film technology which a long time ago might have been considered for less expensive by a company like Honeywell.

The company already is applying deposited interconnection techniques, both in substrate and in extrusions which the Aeromatic Division is delivering.

* **Type III:** Electronic circuits, both organic film for digital computer use and semiconductor diodes, also active devices and circuits for general application. This phase of the company effort is being carried out by the Research and Aeromatic Divisions, with first applications expected to start by 1967.

* **Type IV:** Molecular electronics, or the fabrication of conductive macromolecular polymers in refrigerated environments, is being developed to find parts and subassemblies around 1965-67. Techniques and knowledge coming out of the research in this firm, solid-state

elements and materials are expected to merge for molecular applications. Primary work on this type is in the Research Division.

To integrate and direct the efforts of this multi-division program, Honeywell has named Paul C. Nichols as the company's Micro-Electronics Program Manager.

The three stage microelectronic amplifier, which Honeywell developed to replace a more conventional amplifier in the B-52 fuel control system, represents a 50% weight reduction in the power requirements. Both are built from a reliable component for the new amplifier for each 15 individual and mechanical connections compared with 210 connections in the previous design.

The B-52 micro-amplifier is fabricated on a fiberglass substrate which is shaped in the form of a sector of a dodecagon whose outer diameter is 1.8 in. and whose width is 0.7 in.

A combination of photolithography and carbon deposition techniques is used to insulate the copper conductors and the cathode material on the glass substrate. Conventional deposition is used to insulate at those holes in the substrate after the conductors and conductors have been fabricated.

Honeywell is able to produce de-



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VACUUM DEPOSITION and photolithography processes are used to produce microwave resistors and copper resistors on glass substrate in sequence shown (left). Vacuum deposition chamber (at far left in right-hand photo) contains oscillator which automatically holds position when position reads desired value of resistance. Vacuum tool at right contains experimental microwave gas set up.



and microwave resistors with values ranging from 10^3 ohms to two megohms according to Thomas Colletta who heads the microwave division within the Aeromechanical Division. Value of the deposited resistance can be controlled to better than 10% during substrate deposition by means of a monitor strip. During the process, the substrate and the monitor strip are mounted on a rotating disk, so that microwave is deposited simultaneously on both. Surface of the monitor strip is continuously measured and the process is halted when it reaches the predicted value.

Although Brunswick had no previous experience in the capacitor field, the Research Division's work in laser materials enabled it to come up with a deuterium-tetroxide tantalum capacitor which was significantly smaller than available commercial units. The Aeromechanical Division is now producing these units on a workshop basis, rated at 250 millifarads, which measure only 0.16 in. diameter by 0.010 in. thick.

Meanwhile, the Semiconductor Division has developed a number of ultrathin metal films on a common substrate, many of which are expected to be available as prototype quantities by early 1961 according to Nielsen.

Typical counts include a

single-stage amplifier and a

12-stage dual DR gate.

The diode gate circuit consists of

12 diodes diffused in a circle on a

0.115 in. square Nitrophenol die.

Each diode measures 0.007 in. in diameter. A signal at one of the 12 inputs will be conducted to the output diode through the remaining 11 diodes.

The device is expected

to find its first application in an arc

house digital computer being developed at Honeywell's Research Guidance Laboratory in Minneapolis, Minn.

Another solid state circuit, Management Electronics has developed a decoupled two-stage amplifier with a large input-to-output ratio, and commercially available transistors. It consists of two wide transistors, fabricated on a single crystal, with only an electrode

junction to connect the emitter of one transistor to the base of the other.

An experimental model exhibits a gain of about 1,300 at a collector current of 100 ma, with resistive load age, matched and unmatche voltage. The complete two-stage amplifier fits inside a standard TO-5 transistor pack age.

Resistor Effect

Several examples illustrate the basic type of work under way in Brunswick's Research Division:

- Resistible anisotropy that film, whose direction of easy magnetization can be changed by room temperature (or below) by the application of a very low magnetic field, in contrast with conventional ferrite materials, that film, whose direction of easy magnetization can be changed by room temperature (or below) by the application of a very low magnetic field, in contrast with conventional ferrite materials. This resistible anisotropy film permits fabrication of a very small, high-current, non-destructive magnetic storage device for digital computers without attempting to control the direction of easy-magnetic-field after the system is energized. Computer scientists expect that this low-hysteresis (10^{-3} Oersteds with no bias) film will have a 10% variation in tolerance between individual elements in the matrix.
- The ability to shift the easy direction of magnetization through the application of a small field suggests the possibility of using the phenomena for computation as well as for information



GASKETS in Design Engineering



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At last—a spiral-wound gasket as thicker than a wedding ring! Ideal for limited space or tight access applications, this new Garlock GASKET is available in thicknesses as small as $\frac{1}{16}$ " or as thick as up to $\frac{1}{4}$ " LD, maximum flange width $\frac{3}{4}$ ".

Controlled density yields more positive seal. During manufacture of the new "wedding ring" GASKET, the preselected thickness of fiber material and preferred metal, the number of laminations of fiber and metal, and the correct tension of fiber and metal while being formed into a gasket are the factors engineered to achieve proper gasket density. By controlling and varying these factors, Garlock is able to match the density to the pressure rating. This built-in quality is constantly checked by a Baldwin-Lima-Hamilton compression-testing machine, thereby assuring perfect sealing regardless of the pressure.

High-temperature, high-strength construction. The new Garlock "wedding ring" GASKET operates effectively at temperatures as high as $+1900^{\circ}\text{F}$ and pressures to 2800 psi or more. It is an excellent gasket where recurring temperatures are encountered. In the 500°F to 1000°F range, Garlock uses a compressed asbestos fiber with stainless steel mesh; in the 1000°F to 1900°F range, a ceramic fiber is used with several different types of metal mesh, depending on customer preference. The ceramic is non-flammable, completely inorganic, and an outstanding chemical insulator. It resists mold, mildew, and fungi, thereby allowing indefinite shelf-life.

Where service is severe and space is a premium, the new Garlock "wedding ring" GASKETs. They may be the answer to your sealing problems. Find out more from your Garlock representative. Call him at the nearest of the 26 Garlock sales offices and warehouses throughout the U. S. and Canada. Or write Garlock Inc., Paterson, N. J.



Miniature Memory Drum

Minister memory drum, using an ionizing beam, can store 35,000 bits of information on an 8.6 mm diameter sphere. Developed by Sperry Gyroscope Co., drum consists of two hemispherical shells which form on the ends of a short metal surface. Drum stores at 30,000 cps.

Silvery Another possibility suggested by Hoechst scientists is to use polarized light as a resistive means for information stored on the film.

- Large area solar cells made from the deposition of polycrystalline silicon instead of single-crystal silicon and its investigation as a means of reducing the cost of solar conversion. Experimental work has followed through on the use of a thin film of polycrystalline silicon deposited onto a substrate, low temperature sputter voltage of 0.5 eV , compared with 0.5 eV for conventional solar cells. Conversion efficiency at about 1%, considerably lower than the 16-18% now attained with single-crystal cells. However, Hoechst points out that they already have improved conversion efficiency by a factor of 100 from the first units made and believe it can be pushed up much higher. One means of doing this now under investigation is to convert grain size of the silicon when it is deposited on the substrate to provide a crystalline orientation which greatly enhances the photoelectric effect.

- Electrical properties of semiconductor films are under intensive investigation as part of Hoechst's goal of developing techniques for depositing single-crystal semiconductor films on metal substrates. Once this can be done, the way is open to producing complete diode circuits, including thin-film elements by deposition processes. One typical study is the investigation of the sorption of gas by a semiconductor film and the resultant effect on its electrical properties, such as carrier

concentration and mobility. In one experiment, using a film of lead telluride, Hoechst scientists found that exposure to oxygen caused the semiconducting metal conductivity to decrease sharply with time, then it began to drop slowly again.

After a week's exposure, conductivity had returned to its original value and remained constant.

Their present work is now progressing rapidly in developing a single crystal film of silicon on an iron substrate, although a number of approaches are under study at one stage.

One of the more promising techniques, according to Hoechst, is to deposit a polycrystalline film, by sputtering at vacuum deposition, and then to use an electron beam to heat the surface locally until it becomes a metastable glass at a place just off the substrate. A similar technique, using a resistive heat source, would involve plotting a groove in the film, making it possible to "write" the crystal structures on successive sublayers by controlling the position of the heat source.

Using the suitable resistives, Hoechst scientists say it should be possible to produce a non-destructive reading type structure with a capacity of one million bits, in a circle covering 2 to 4 m² per side. However, the high density packaging will pose initial casting problems.

One possible solution under consideration by Hoechst is the use of thinfilm Peltier (thermo-electric) cooling to transfer residual heat to an external heat exchanger.



Bottle Display Console

New display console for shelving stores of little display space allows air, moisture and temperature control. GM model generates plotting board which it is exposed to vapor in shelves behind. Display console, developed by Hughes Aircraft Co., is part of new Navy Technical Data System (NTDS), now being tested for service test.

Vanguards to Get Collins Autopilot

Cofair AF-105 autowave pilot has been approved by British Air Rights now issued to British Aerospace Aviation. First of British Vanguard transports to receive the system, eight aircraft have two sets of instrumentation of the cockpit on a Vanguard and following four sets by Vickers.

Initial operational Vanguard was delivered to TCA in December, 1968. The TCA Vanguards also are fitted with Collins PD-105 flight director units and a complete Collins communications and navigation system, including the DC202 automatic direction finder, FIN-1 VHF receiver, UTL7 VHF transceiver and 244B-VOR omnireceptor unit.

FILTER CENTER

Sperry Boots ECM Take PowerWith traveling wave tube, capable of generating 3,900 roths output at X-band, has been developed by Sperry Gyroscope Co. using a high-velocity tube held in a case measuring 2 to 6 m² per side. However, the high density packaging will pose initial casting problems.

One possible solution under consideration by Hoechst is the use of thinfilm Peltier (thermo-electric) cooling to transfer residual heat to an external heat exchanger.

▪ **Nav. Launchers Avionics Checkout Program** P. S. Electronics will make a basic engineering study on rail-launched checkout systems for avionics equipment under Navy contract from Naval Systems Division of North American Rockwell Corp.

▪ **Solid State Curriculum Established** Pennsylvania State University has established a graduate level course program in solid state electronics in M.S. and Ph.D. degrees in Solid State Technology. Candidates will be accepted beginning with the 1961-62 school year. Information on the program can be obtained from the Dept. of the Graduate School, Pennsylvania State University, University Park, Pa.

▪ **IRC Enters Spacebridge/Field-Intertel Contract** Co., a major supplier of receivers, has purchased interests in North American Electronics, Inc., Lynn, Mass., which produces space-oriented and X-ray diodes.

EQUIPMENT

Angle-of-Attack System Proposed for Jets

By Harry Tally

SYRACUSE, N. Y.—Standardization of jet transport takeoff, climb, approach and landing instruments has been proposed by means of an angle-of-attack instrument and a relatively high-speed indicator.

The angle of attack of a wing configuration, being constant for best lift/drag ratio regardless of airspeed, gross weight, bank angle, landing and other variables, is sensed at flight level and is even measured at point of the flight in streams of many jet transports. That a pilot should have at his disposal an instrument which, with minimum cockpit instrumentation, can present both climb and descent information, gross weight, speed, and maximum airspeed/bank angle while holding at low speeds, is without requesting for gross weight, unbeat at present, etc.

Diversity Cited

The diversity is all that is in presenting the angle-of-attack information to the pilot so that it can be used for flight control. Angle of attack is a large aircraft change variable, making an indicator serving that change uniquely sufficient as a flight control instrument.

Spartan, Inc., Syracuse, N. Y., maker of angle-of-attack instruments for Navy jet fighters, has developed a system which can provide the necessary information of angle of attack change by means of an automatically selected speed indicator. The extra cost, standard air data tubes, can best prevent sensing with anemometers.



AIRSTREAM direction detector is mounted on side of fuselage to sense angle of attack.

ter signals to eliminate much of the relative lag in the pressure sensing device.

The company has proposed flight testing of its system to be conducted at the Bureau of Research and Development Atlantic City, N. J. Use of the aircraft angle-of-attack system, as proposed by the company, calls for establishment of constant angle of attack. In terms of the angle-of-attack indicator and maintenance of the unbalanced climb (or descent) by means of the current gear instrument.

Spartan, Inc., sees that angle-of-attack control, by eliminating the need to compare reference signals, can provide, with the angle-of-attack position, what can now be given in 10 pages of cockpit instrumentation and procedure. Included are the normal and emergency conditions which may be controlled by means of the angle-of-attack, indicating the breakoff rotation attitude, angle of gear failure on roll-off set and direct climb on roll-off set and no gear down climb with one or two engines out.

In sum, with four engines operating, cruise climb is flown at constant Mach. Other flight modes tested by

sensations angle of attack for standard flight mode at the 2° climb position on the attitude dial. At angles of attack increased, the position moves counter-clockwise to the 9 o'clock position, representing climbing angle of attack. Intermediate positions are marked for special flight modes such as those engines wet and three engines dry.

Spartan, Inc., sees that angle-of-attack control, by eliminating the need to compare reference signals, can provide, with the angle-of-attack position, what can now be given in 10 pages of cockpit instrumentation and procedure. Included are the normal and emergency conditions which may be controlled by means of the angle-of-attack, indicating the breakoff rotation attitude, angle of gear failure on roll-off set and direct climb on roll-off set and no gear down climb with one or two engines out.

In sum, with four engines operating, cruise climb is flown at constant Mach. Other flight modes tested by



INDICATOR shows best angle of attack for both normal and emergency flight modes



APPROACH selector presents angle-of-attack information on final approach speed.

AVIATION WEEK, February 27, 1961

the angle-of-attack indicator enables maintenance engineers to make approach with either the aircraft flying at 40 ft/sec or the aircraft in level flight.

During landing at reduced speeds, the indicator should prove useful in that as before (and still) each angle decrease with increased the indicated angle of attack remains constant.

The approach modes provide a visual angle-of-attack reference while the pilot is looking at the runway. This indicator measured on the instrument glass shield represents the test extension of the position-indicating angle-of-attack indicator. Presented with "first" (low angle of attack) and "last" (high angle of attack) readings, the approach modes can also indicate when the pilot has too much angle of attack. These modes indicate vertically, high enough to provide for indications which can be interpreted by the pilot as "very slow, slow, on speed, fast, very fast."

Designed to give the pilot angle-of-attack information during the visual contact phase of an instrument approach and throughout a normal approach, the approach is intended on the glass shield within the pilot's peripheral vision.

The idea is to provide a sensitive angle-of-attack index and to display it in a manner that will lessen the amount of head bobbing in the pilot divided his attention between the runway and the instrument panel.

Stabilizing Block

Spartan, Inc., wants that a major stabilizing block in the path of angle-of-attack indicator acceptance is centered on the part of space plane between the relative angle of attack (angle formed by the relative wind and the wing chord) and the aircraft angle of attack. Additionally, the fact that even those who know the difference have had to seek the best angle of attack by means of speed indicators (which are subject to variations and errors).

They are requested to leave the air speed indicators with their known deficiencies for an auxiliary readout (nonconcurrent) quantity. That pilot can judge to compare reference air speed rather than pilot air speed data in a sum dial. In this respect a "fast-slow" speed indicator, although not always correct from an aerodynamic standpoint, seems to have advantages in the area of human factors.

The first benefit of angle-of-attack flight instruments has been by the Navy. The need for an angle-of-attack indicator was first recognized in connection with catapult launching aircraft from aircraft carriers. During catapulting jets with power and flap sets were conditioned above normal and an absolute altitude of about 70 ft is

or to feel best lift/drag angle of attack with steady state often results in pitch-up maneuvering. Night operations with glide in no roll horizon compound the problem.

Installation of angle-of-attack indicators on the Navy jets proved to be of value after considerable pilot education as to use of the instruments. The angle of attack, indicator, independent of gross weight, pressure levels and other variables would indicate only on catapult takeoff but on land another view when the instrument is used in a pulling steep turn at high altitude.

In that instance the instrument would tell the pilot when steep turn stalls are reached.

Throttle Control

Spartan sees that the Navy signal an automatic throttle control to its angle-of-attack sensor after experiencing marginal results with simple sequencing. The test method, Canfield Vought F8U fighter, was flown through an approach with the throttle controlled by the angle of attack sensor. The test data types showed that the plane was held within one knot of planned approach speed. This suggests that angle-of-attack instruments could be used for the same purpose in automatic instrument landing systems. Most systems now under test seem to reject the control power.

The Federal Aviation Agency is studying Spartan, Inc.'s proposal to explore angle-of-attack measuring systems with the idea of establishing standards for angle-of-attack sensors if they are deemed valuable on jet transports.

The proposed flight evaluation of the angle-of-attack indicator will be conducted with a Grumman F9F-8T fighter equipped with a standard Navy angle of attack indicator. Selection of aircraft seems appropriate because of its extremely maneuverable to jet transports, capable flying the aircraft with high gear wheels down and at high levels reduced compared with older

In-Flight Tests

The test aircraft should be fitted with the normal lead vertical speed indicator, provided by Spartan, Inc., to stabilize climb/breakoff paths. With the plane stabilized at best climb angle of attack, any gradual departure from that angle would be felt easily as the vertical speed indicator.

The Grumman F9F-8T will permit the crew to understand quickly a rapid landing without roll breakoff. At first the aircraft comes down the runway descending about 600 ft/sec, visual rate visible at 50 ft/sec indicates aircraft has passed through 70 ft absolute altitude. Under these conditions descent toward the runway and a slowing to 500 ft/sec. At night landing flare out as indicated by the pointer indicating 60 ft/sec sink rate and hope indicates clearing the aircraft just off the runway surface.

WADD Tests Cockpit Landing Instrument

New York's cockpit landing instrument displaying bright light above ground and instantaneous visual speed for automatic landing will be flown over Wright Air Development Division in Lockheed F-104 and Convair C-131 aircraft.

The control tests, design, calibration and system operation from AN/APS-27 radar altimeter outputs, is being evaluated by WADD's Flight Control Laboratory. Its inclusion is an automatic landing program being conducted jointly by WADD and the Federal Aviation Agency. The Instrument Division of Lear, Inc., Grand Rapids, Mich., de-



SEQUENCE PHOTOS show the Lear 25's landing sequence during a typical landing cycle and rollout. FIG. 1 shows the aircraft coming down the runway, FIG. 2 shows the aircraft leveling off, and FIG. 3 shows the aircraft landing flare out as indicated by the pointer indicating 60 ft/sec sink rate and hope indicates clearing the aircraft just off the runway surface.

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A 20,000-ton forging press designed by Canadian Iron Works, Houston, Tex., designed for use with high density alloy steels and the relatively malleable cast irons, is ready for operation. It can produce extremes up to 10 ft long and 24 in. in diameter.

veloped that extramat and bar rates less than 1,000 lbs per hour against the fixed control limits. The absolute ultrasonic speed selector will give either both normal descent and a rate of descent, or mat descent. In an emergency landing at "normal" conditions, the instrument would provide an automatic reduction of rate of descent to 1/2 in. or less if tendency to fast down the runway prior to touchdown. The instrument can also be of value in heavy jet aircraft which are at a study rate of descent. Here the rate of descent reaction of the attitude instrument and its independence of change in "absolute" conditions would be advantages.

The landing attitude and depth absolute selector by means of a large ultrasonic landing loop on the right of the cockpit console. At an absolute altitude of 200 ft, the loop opens at the bottom of the scale and moves upward toward a arm standing at 90° aircraft demand. Vertical speed is indicated as either climb or dive by a pointer and against a scale. The indicator provides vertical speeds from 200 to 40,000 fpm between 40,000 and 5,000 fpm a pointer fixed beside a vane or scale provides a tape displaying vertical rates in thousands of feet. At

initial testing of the landing instrument was conducted with a T-33 flight simulator. Tests were run to determine whether pilots could make a smooth descent. Layout and touch down using the landing instrument. Eight tests will determine the instrument's usefulness in actual aircraft

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SOLID propellant cartridges are loaded into the motor assembly for test firing.

Small Turbine Starter Cartridges Developed

McGregor, Tex.—Solid-propellant cartridges, weighing only 31 lb., can be used to start and check their own aircraft turbine engines. Starter cartridges achieve a clean, cool-burning propellant and have been tested successfully through a temperature range of -70° to 150°.

Measuring approximately eight inches long by six inches in diameter, the cartridges produce 450 gas horsepower for 17 sec. In operation, the units would be mounted in a special writer bracket on the aircraft; the pilot would ignite the unit and the gas stream would spin a small starting turbine which, acting through a gear train, would ignite the jet engine turbine.

The cartridge is designed to burn rapidly to eliminate weight of extra insulation and to minimize external temperatures on the cartridge during firing.

Unit has been designed and built by North American Aviation Rockwell Solid Propulsion Operations.

Fuel Safety System Developed for B-70

A unique safety system for the North American B-70 has been delivered to North American Aviation by the inventor's development, the Fader Aircraft Co. and Arthur D. Little, Inc.

Designed to prevent auto-ignition in the high-heat regions of high-temperature gas developed at Mach 3, the system monitors a pressurized nitrogen pressure and stratification in the fuel system. Nitrogen carried in liquid form is converted to gaseous form and accumulates cells, vented to the tanks by a piston-operated servo system. Pipes, valves and fittings are cleaned at the nozzle and are replaced by integral gas piping in a manifold to which valves are attached.

MODULAR TELEMETRY RECEIVER FEATURES MULTIPLE BANDWIDTH SELECTION



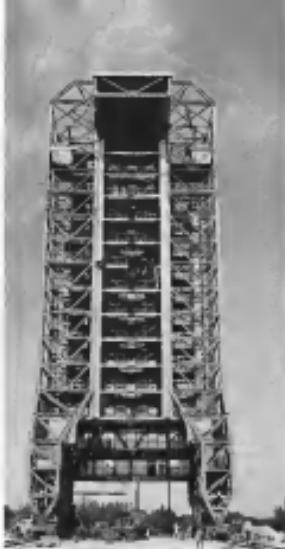
The CENTAUR Receiver used by NASA
Nema-Clarke Model 1455

Designed to provide a selectable bandwidth capability for PCM, the 1455 most nearly approximates a "universal" telemetry receiver. IF Demodulator Modules are available in bandwidths ranging from 500 KC to 1.5 MC. Each module contains 3 independent demodulators. Selectable by a front panel switch, they are Foster-Seeley Discriminator, Phase-Lock Detector, and AM envelope detector. As a further enhancement in signal-to-noise ratio enhancement, the video amplifier incorporates a video bandwidth filter having a 6.49 per octave roll-off adjustable from 20 KC to 1.2 MC by means of a front panel switch. This receiver is capable of automatic reception of any known type of telemetry signal. Features: 5 MC pre-selectors; recording output, playback input terminals, and integral VFO, automatically activated by a microswitch on the crystal socket. The modulation sensitivity and deviation meter scales provide output voltages and meter deflections which are essentially the same percentage of bandwidth in all models.

Available as an accessory unit is the Nema-Clarke HFD-1455 Pre-Demodulator Converter which permits use of the 1455 with stationary head instrumentation tape recorders for pre-selection recording.

See the 1455 Receiver at the I.R.E. Show, Booths 3917-3919.

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Close-up service tower areas completion of the Atlas-Centaur Complex. The 173 ft. tower, pad and blockhouse constitute Complex 36.

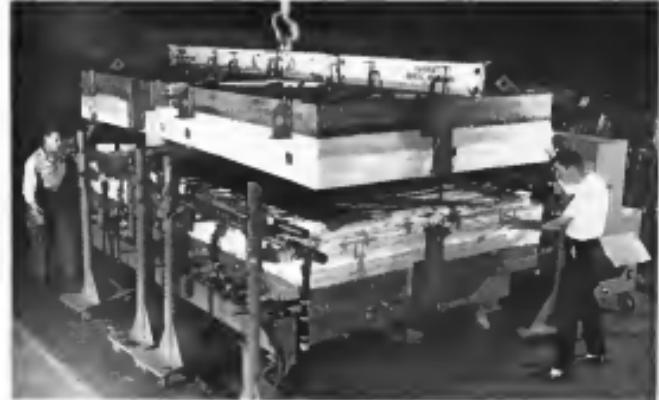


Atlas-Centaur Tower Nears Completion

Atlas-Centaur Complex 36 is being prepared for an Atlas-Centaur space vehicle launch this summer. The Centaur is a Canadian National Aerospace and Space Administration project. The Centaur tower is 173 ft. higher than the Atlas-KBM launching tower of Complex 11. The tower sits on 18 column-type wharfs mounted on blocks. A hydraulically-powered rock and soil compactor machine is used to settle the deep foundation and the ground is reinforced by the sheet piles and grout injection utilized in the Atlas construction. A permanent 53-ft. steel-tipped tower on the cleared launch pad is topped by two hydraulically-reinforced bottom wharfs carry fuel, power and control mission lines in the upper stages. The 75-ft.-dia. x 181 ft. high blockhouse is covered by 5-ft. thick reinforced concrete, topped by packed sand. The blockhouse is built on two levels. Top level contains control console and a glass enclosed booth for vision. Lower level is utilized for launch service equipment and a crew ready room.



Large honeycomb panels are housed between two air insulators in the electric-blaster braiding fixture.



Mach 3 Manufacturing

Making an aircraft skin tough enough to withstand the heat barrier

To cope with the heat barrier and erosion of speeds in excess of 2000 miles per hour, an aircraft needs a skin thicker than that of any plane in existence. Traditional covering methods were out of the question.

To solve this problem, the engineers and scientists of the Los Angeles Division of North American Aviation carried on further experiments with the techniques of sandwiching skins in steel honeycombs. They found that by sandwiching this honeycomb between two sheets of steel, sometimes only six thousandths of an inch thick, structural strength could be obtained with excellent radiating characteristics and stiffness approaching a solid slab of steel, yet would be light.

The problem of having these honeycomb panels to meet the increased temperatures of Mach 3 speed inspired an

intensive development program. In cooperation with NASA's team of subcontractors, experiments were made with many kinds of braiding methods. One in particular would give high quality results with economy. This method utilizes a ceramic form to hold a honeycomb panel at controlled heats of over 1600° engine.

As a result of this advanced development in the art of making aircraft coverage, a plane can now have a skin so tough it is well able to withstand thermal speeds.

This technology at honeycomb will help ensure America's leadership in aircraft and make possible the supersonic transport, weapons systems and commercial aircraft of the future. Because of outstanding achievements in aerospace invention, the American Society of Metals gave North American its 1959 Achievement of Research Award.

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FAFNIR BALL BEARINGS

save space, assure actuator reliability

Fafnir-equipped twin tub actuators, parts by Allis-Chalmers, Marquette, Wisconsin, and by Garrett Corporation, Milwaukee, are operating loads of 500 lbs. in one axis, 1000 lbs. in the other, 900 lb. static load capacity.

Two of the Fafnir Ball Bearings in this Allis-Chalmers actuator have outer rings only $\frac{1}{2}$ " wide. There are five more Fafnir bearings only $\frac{1}{8}$ " in width, and a $\frac{3}{16}$ " wide. Dimensions like these add up to important space and weight savings. But more important is the reliability. Fafnir designs into these extra-small precision ball bearings

All are permanently prelubricated and shielded against contaminants. Expander parts of the cylinder rod bearings are carbonized plated against cor-

FAFNIR
BALL BEARINGS

resion, and the shafts are stainless steel. The PA-KDD bearing on the motor is stainless steel throughout. These Fafnir Ball Bearings meet necessary environmental requirements and provide high relative load capacity. They assure smooth, low torque operation and have the ability to withstand severe vibration.

If bearing size, weight, and reliability are important in your products, let Fafnir help you. Write The Fafnir Bearing Company, New Berlin, Conn.

Stock Transactions

Recent news of stock trading in the aerospace industry seems to have shifted to the buying side; note the acquisition of stock through the use of large options. These could be a number of reasons; lower prices of many stocks, making them more attractive buys, feeling that outlook for business has improved; unawareness of new issues.

The following transactions for the period Sept. 14 to Nov. 18, 1966 have been reported in the Securities and Exchange Commission:

Aerospace Corp. Acquisition of 100 common shares by John R. Henn, director, holding a total of 100 shares. Acquired 100 common shares by Robert L. Lutz, officer, holding a total of 1,000 shares. Acquired 100 common shares by Thomas E. McNamee, executive racing a holding of 17,641 shares. Acquired 100 common shares by Joseph W. Mullen, officer, holding a total of 100 shares.

Aviation Air Lines Inc. Acquisition of 100 common shares by John R. Henn, director, holding a total of 100 shares. Acquired 100 common shares by Lorien W. Miller, officer, holding a holding of 100 shares.

Electrical Power & Marine Corp. Acquisition of 100 common shares by Donald L. Foy, director, holding a total of 100 shares. Acquired 100 common shares by W. H. Koenig, officer and director, holding a holding of 800 shares.

American Brush Arms Corp. Acquisition of 100 common shares through purchase of 100 common shares by D. C. Knapp, director, holding a total of 100 shares. Acquired 100 common shares by W. D. Morris, director, holding a total of 100 shares. Acquired 100 common shares by J. G. Morrison, director, holding a total of 100 shares. Acquired 100 common shares by John S. Morrison, director, holding a total of 100 shares. Acquired 100 common shares by James W. Morrison, director, holding a total of 100 shares.

Bendix Corp. Acquisition of 100 common shares by A. P. Frazee, officer, and 100 common shares by C. E. Johnson, director, holding a total of 100 shares acquired by Charles

Tillgham, Jr., officer, holding a holding of 100 shares.

Engineering Corp. Acquisition of 100 common shares by James R. Setzer, officer, holding a holding of 1,475 shares.

General Dynamics Corp. Acquisition of 6,012 common shares by T. A. Bowes, officer and director, holding a holding of 6,012 shares. Acquired 100 common shares by Robert L. Lutz, officer, holding a holding of 1,000 shares. Acquired 100 common shares by Thomas E. McNamee, executive racing a holding of 17,641 shares. Acquired 100 common shares by Joseph W. Mullen, officer, holding a holding of 100 shares.

Pratt & Whitney Co. Acquisition of 100 common shares by William P. Lane, director and president, holding a holding of 100 shares. Acquired 100 common shares by John R. Henn, director, holding a holding of 100 shares.

United Corp. Acquisition of 100 common shares by John R. Henn, director, holding a holding of 100 shares. Acquired 100 common shares by Charles C. Morrison, officer, holding a holding of 100 shares.

United States Aircraft Corp. Acquisition of 100 common shares by John R. Henn, director, holding a holding of 100 shares.

Vertecal Flywheel Corp. Acquisition of 100 common shares by Donald L. Foy, director, holding a holding of 100 shares. Acquired 100 common shares by W. H. Koenig, officer and director, holding a holding of 800 shares.

Wright Electric Corp. Acquisition of 100 common shares through purchase of 100 common shares by D. C. Knapp, director, holding a total of 100 shares. Acquired 100 common shares by J. G. Morrison, director, holding a total of 100 shares. Acquired 100 common shares by John S. Morrison, director, holding a total of 100 shares. Acquired 100 common shares by James W. Morrison, director, holding a total of 100 shares.

Wright Research Corp. Acquisition of 100 common shares by John R. Henn, director, holding a holding of 100 shares.

Wright Safety Devices Inc. Acquisition of 100 common shares by John R. Henn, director, holding a holding of 100 shares.

Yerkes Industries Inc. Acquisition of 100 common shares by John R. Henn, director, holding a holding of 100 shares.

options shares to Wily M. Hilliard, officer and director, holding a holding of 1,451 shares. Acquired 100 common shares through exercise of stock options by John R. Henn, director, holding a holding of 1,451 shares.

Yerkes, Inc. Acquisition of 100 common shares by William P. Lane, director and president, holding a holding of 100 shares.

Zeller Bros. Inc. Acquisition of 100 common shares by Charles C. Morrison, officer, holding a holding of 100 shares.

Zimmer Corp. Acquisition of 100 common shares by John R. Henn, director, holding a holding of 100 shares.

Zodiac Industries Inc. Acquisition of 100 common shares by John R. Henn, director, holding a holding of 100 shares.

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PROBLEMATICAL RECREATIONS 55



The faces of a solid figure are all triangles. The figure has nine vertices. At each of six of these vertices, four faces meet, and at each of the three other vertices, six faces meet. How many faces does the figure have?

...Continued

No less than 204,000 square feet is the total space for research, development and production of microwave tubes and display devices at our Electron Tube Division in San Carlos, California, after addition of two new buildings. One of the buildings is supplied with 3.2 million watts of power for testing. The new facilities cost more than \$1.5 million and will house special instruments for assembling and testing large dynotrons such as those used in the ballistic missile early warning system.

ANSWER TO LAST WEEK'S PROBLEM. First calculate the times at which the minute and hour hands are exactly 120 degrees or $\frac{1}{3}$ circle apart. Then calculate the position of the second hand at these times, and choose those times when the difference between the hour and minute hands is closest to 120 degrees. The closest difference is $4/11$ (4.3635) circle at $T = 9.1/11$ hours and $T = 2.10/11$ hours. So the answer is 2 hours, 54 minutes, 12 seconds. The only other time could have been 9 hours, 3 minutes, 25 seconds.

LITTON INDUSTRIES
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BUSINESS FLYING



ROVIER 50-hp. biplane in British Currie Wot barn door either kerosene or diesel fuel, engine oil tanks are located in side wings.

Currie Wot Flies With Turbine Power

LONDON—British Currie Wot biplane has been successfully test flown using a T.P. 60-hp. marine engine developed by Rover Co., Ltd., of Solihull, a long time builder of automobiles and aircraft auxiliary power units.

Powership used in the flight at one of two developed by Rover, either a 90-hp. radial aircraft engine or a 100-hp. inline engine. The 100-hp. model develops 320 bhp. and it is nearly the same engine except that it runs at a higher temperature with a modified cylinder. Both powerplants weigh 235 lb.

The smaller model utilizes a fully automatic variable pitch propeller, also designed by Rover; larger engine propeller controls are hydraulic. The T.P. 60 has engine ratings for more than 1,000 hr. on beach tests. Company spokesman said the engine, in aircraft application, should have an initial rating of about 300 hr. between overhauls.

Sales Price

Rover officials did not release price of the engine, nor do they with variable pitch propeller, will be about \$4,200. Exports on demand. Industrial operation of the turbine will cost for \$3,400. For the 60-hp. version and \$3,700 for the 90-hp.

Rover entered the turbine engine field in 1940 through an association with Air Commerciale Sir Frank Whittle in development of the Whittle jet

engines for aircraft. Later, Rover worked with Rolls-Royce in design of the Napier and Daimler turbine. In the automobile field since 1904, Rover first tested a turbine-powered auto on May 9, 1938.

In the aircraft field, Rover builds auxiliary power units for the Vickers Lancaster bombers and the Armstrong Whitworth 660 military transport.

Maximum power and consumption of the engines are 1.36 lb./bhp./hr. and 1.45 lb./bhp./hr., respectively.

T.P. 60 is a single-spool engine with a single-stage, centrifugal compressor, one reverse-flow combustion chamber

with down-stream injection and a single-stage turbine. Pressure ratio is 2.93:1 and air mass flow 1.45 lb./sec. at 46,000 rpm.

Compressor supplier is negligible with 17 vanes, wheel of the anti-flow turbine is of Nasco's 90 and turbine inlet temperature is 1,950° at 46,000 rpm.

Skid Speed

Power output is by reduction gear, giving an output shaft speed of 2,125 rpm. Control system is mechanical with automatic overspeed and high temperature controls and variable engine speed.

A Rover multi-piston pump supplies fuel at 250 psi. full-thrust pressure and 650 psi. maximum pressure. It has centrifugal governing with internal adjustment to prevent overspeeding. Rover has designed for the engine a novel automatic variable pitch propeller, mechanically compensated for engine speed and power.

The engine's specific weight is 5.36 lb./hp. and specific fuel consumption is 1.36 lb./hr. at 60 percent rated (70 bhp) at 47,000 rpm and 1.45 lb./hr. at maximum cruise (90 bhp) at 46,000 rpm.

Engines are 20 in. wide, 27.5 in. high and 16.3 in. long, plus a further 13.9 in. for propeller and spares.



ARTIST'S conception shows 50-hp. model in proposed configuration.

T.P. 60 is of identical size and weight, but has an increased rating of 120 bhp. at 47,000 rpm, maximum takeoff and 90 bhp. at 46,000 rpm maximum cruise. Design is similar, but pressure ratio is increased to 2.81 and air mass flow increased to 1.58 lb./sec. at 46,000 rpm.

Turbine wheel is of Nasco's 105 and solar temperature at 1,920°. Specific weight of the larger engine is 1.58 lb./hr. at 60 percent power and 1.18 lb./hr. at maximum power. Engines for the Currie Wot were developed in Rover Gas Turbines, Ltd., a subsidiary of the auto company. Cranking rpm of the 60-hp. model propeller is 2,125 rpm and starting is automatic. Hand's button is 12 s., and instrumentation is air, gage and tripole temperature indicator.

Rover said its flight test program for the smaller engine has been completed and the powerplant was available for commercial sales. Larger engine has not yet been flight tested.

Highest drag ratio of the Currie Wot leaves special in the obtaining with the top speed of 140 miles per hour—57 mph.—at takeoff and climb performance are said to be greatly improved with turbine power.

The airplane was designed in 1937 by J. R. Currie two prototypes were destroyed during World War II bombing raid.

In 1953, the Hestair Aeroplane Club, Southampton, built the plane and in the twelve test flights.

The Wot is a single-seater designed for aerobatics, and the engine can be continued with the Rover turbine, which has an inverted take-off of 15 sec. Nose is 21.5-foot construction and wingspan is 22 ft. 10 in. length is 18 ft. 9 in. and gross weight is 700 lb.

Lockheed Sells 39

JetStar Transports

Approximately 39 Lockheed JetStar four-jet executive transports have been sold and the first delivery is now scheduled for April on March with shipment going into those for corporate and electronic equipment outfitting just prior to the final certification and licensing appointment in June or July after reclassification granted by FAA. Some 20 percent of aircraft customers, said Paul A. Williams, Jetstar Sales Director, Div. and Continental Jet Co., already have entered pre-order status, among them Marquette, Ga. First customer start in late March or early April. Indications are that Lockheed has contributed substantially to the compressor stall problems that occurred when the surface was in a high angle-of-attack position by installing a series of masseners in the engine intake for desired air flow.

By the close of 1958, the carrier had 10 Do-27s, a Paggio P.166 in service and had received the first of four four-engine Do-28s as order. Remaining two Do-28 plus a Paggio PA-16 are scheduled to be delivered in the near future.

During its first six months of operation



DOHERY Do-28 twin and a Paggio P.166 are on the lot at Deutsche Transflug's Memmelsdorf, Germany, facility. First new 18-passenger fleet two of four Do-28s on order.



West German Charter Line Buys Do-28 Twins; Plans Expansion

By Edith Walford

MUNICH—Deutsche Transflug GmbH, a relatively new, rapidly expanding West German charter company, is drafting plans to expand and expand its schedule in 1961.

Founded in April, 1959, Deutsche Transflug began operations shortly after completion of four single-engine Do-28 turboprop transports for the Blaustein Air Service, a Munich-based regional airline, and the traditional Blaustein Industrial Fair held in Munich at the opposite end of town. Charly for the 7-mos. period between the two trips was 57.0 per percent.

By the close of 1958, the carrier had 10 Do-27s, a Paggio P.166 in service and had received the first of four four-engine Do-28s as order. Remaining two Do-28 plus a Paggio PA-16 are scheduled to be delivered in the near future.

Transflug also plans to introduce direct nonstop Do-28 service between Hamburg and the island of Helgoland in the North Sea, a route it checked out

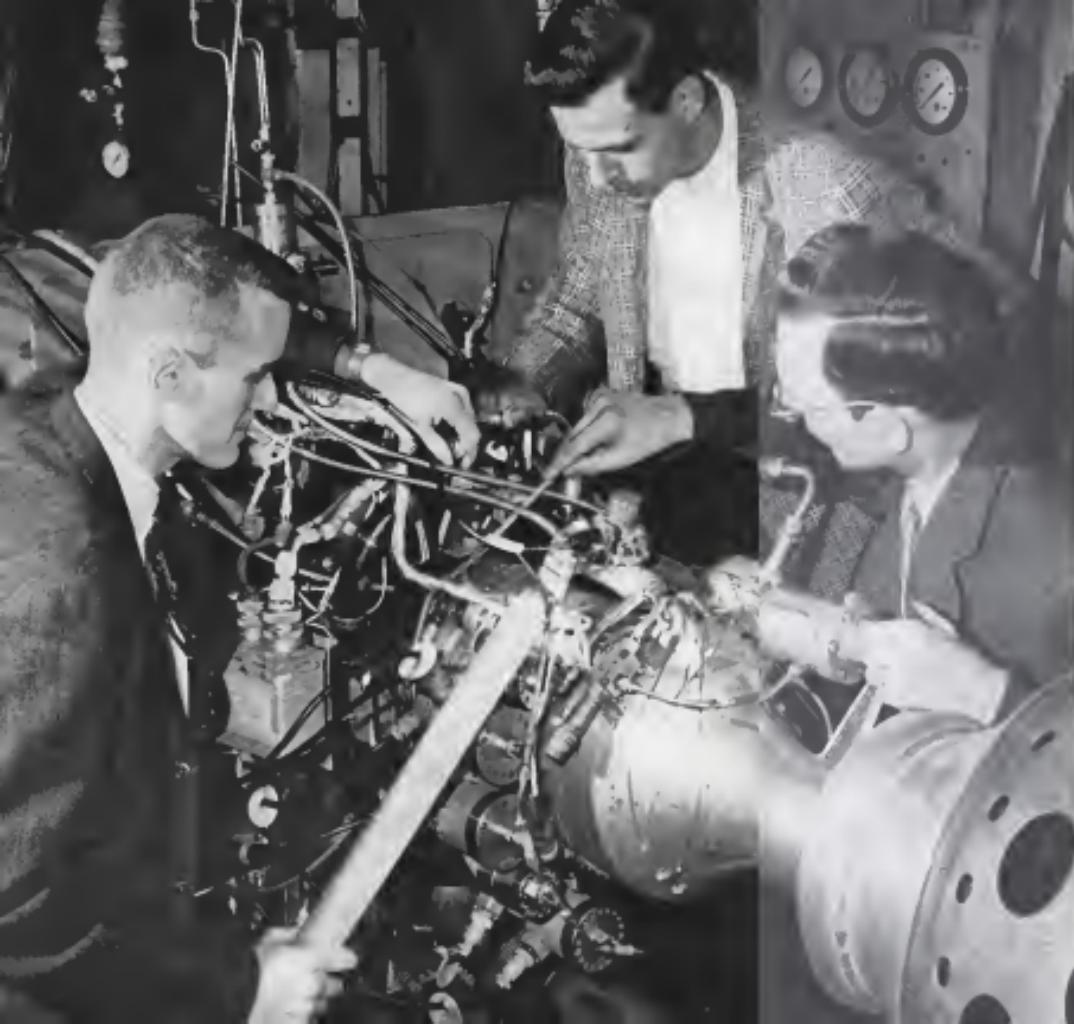
from Apr. 1 to Sept. 10, 1959. Transflug carried a total of 11,000 passengers on 4,347 flights covering 115,120 mi.

Company figures for 1960, over a slightly longer time period—Apr. 1 to Nov. 30—show that the line carried 14,185 passengers plus 60 U.S. tons of freight on 4,905 flights over a distance of 167,500 mi.

Transflug will serve the first large domestic market and help fill the growing demand for chartered transportation services to a number of other European countries, particularly Italy, France, Switzerland and England.

To be portable on short notice, the Do-28 will be maintained at four of Germany's major airports—Frankfurt/M., Münich, Mannheim, Düsseldorf and Magdeburg. The two aircraft already on hand are operating from Frankfurt/Münich and Mannheim.

Transflug also plans to introduce direct nonstop Do-28 service between Hamburg and the island of Helgoland in the North Sea, a route it checked out



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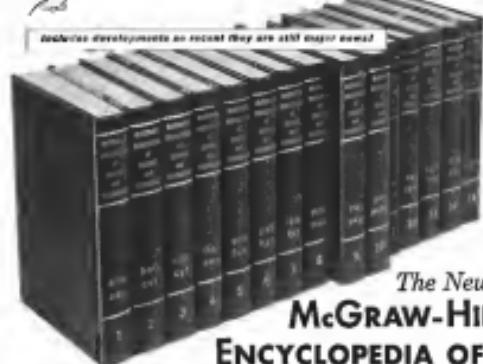
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Set rear on piston flights with the Twin Tugboat. Present plans call for two 100-hp. Dahlwood motors, supplemented when demand warrants by Twin Pegasus flights.

Dahlwood estimates the eight-hour cost of the various aircraft now, in 1968:

- Present Detroit Do-27—\$85
- Present Detroit Do-33—\$83
- Eight-seat Paggio P-166—\$115
- Two-seat Piper PA-38—\$70

The company's provisional 1968 flight operations include:

- Air taxi services from Montreal, March, Franklin/Montréal, Hochelaga and Terrebonne.
- Shuttle services between Montréal-St. Jean and the South International Shore, Lachine and Macdonald Pier of Montréal.
- Shuttle airport services from Dorval, Beauport, Laval and Hochelaga to East and North Franklin and Hérouxville.
- Charter services between Montréal-Fordhook/Mont-Sainte-Anne-Perron/Pointe-Mile-Moreau.

Examples of typical charges per person for the round trip flights include:

- Franklin-Fordhook—\$12
- Franklin-Sainte-Anne—\$17.50
- Franklin-Mile-Moreau—\$15
- Sainte-Anne-Mile-Moreau—\$19

Tudling cast off interest among German manufacturers and journals in favor of another, a Canadian firm. With the addition of four Do-27s, it is now seven, Tudling Tudling appears to again boost its year-end results considerably.

Mooney Sells Stock For Working Capital

Requirement for additional working capital to build an inventory of aircraft needed to increase production levels beyond current targets has led Mooney Aircraft, Inc., Kerrville, Tex., to issue some 40,000 additional shares of stock, which will bring its stock outstanding to a total of some 150,000 shares.

Mooney President Hal Radul started offering "treasury stock," as James said later, that the total offering will bring in approximately \$400,000 of working cash which will be utilized in step-up production of the new all-metal Mark 22 four-place business plane (EW Feb. 20, p. 19). From a one-shade schedule beginning May 1 to double that rate at the end of June, The new price currently is backdated through July on the Mark 21.

Increased working inventories would permit production of some 45 airplanes monthly beginning in July, bringing the firm a gross business of some \$600,-



Ski Developed for Tricycle Gears

New skis concept for single-pilot lightplanes is being put into production by Fladness Corp., Minneapolis, Minn., early in summer here as a Canoe 202. Skis allow a load transfer plate connected hydrodraulically from the cockpit, to move these from the "ski" position, in which wheel extends through the ski, to conventional banking, to "ski" position, where wheel sits on the tip bar.

\$60 monthly and a set of skis \$50,000 assembly. Radul noted.

Radul emphasized that he is seeking investors who are not interested in speculative projects, but who also have talent. They may be asked to contribute to the company's development of equipment in the financial and technical fields. Radul, who has an independent income, and has not taken a salary out of the company in recent years.

He is returning his current holding of some 71,000 shares. This, with Ed Evans' Vice President Norman Hoffmann's holding of some 40,000 shares and approximately 10,000 shares held by Mooney Aircraft, Inc., an affiliate could be reduced to maintain control over the company. Radul told Airways Weekly that the firm is only 10 years old, but that the current offering will be controlled by some 40,000 shares for use in case time in the future if further rapid expansion is required to support new development of the company's aircraft line.

Indications are that these 30,000 shares are still remaining, with price in the neighborhood of \$15. Full of shares released that he has been informed by Ed Evans' distributor.

PRIVATE LINES

United Airlines Sales, Inc., flight school Wichita, Kan., has become the third school to be authorized by the Civil Aviation Agency to conduct private pilot's license training. The new division is located in Wichita, Kansas, California and Nevada and Oregon.

King Commercial, Inc., has cut the price of its Comanche 406A from \$73,000 to \$67,500, making it more competitive with Cessna 172 and reducing price gap with the Comanche 196B (\$81,500).

F-4H

B-52

B-58

F-106

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Department of C-44 (former VH-CV), had displayed unusual readings of the instruments operated by its post static system, and that at the conclusion of one test flight, the post static system had not been cleaned from that action. Further reference will be made to these and other incidents of a similar kind at a later stage of this report.

Ground Rig

This section led to initiation of experiments to determine the physical effects and a possible role in the genesis of disturbances that effect aircrew health could have on the operation of the instruments. The results of these experiments were discussed earlier on the ground rig below the board.

The following conclusions were made, I think the following conclusions:

- That water in the system on the site board rig would not produce errors in the shunting or that side. The automatic pilot was not connected under the floor of the cockpit to the static ports on that side of the aircraft. The static ports were in the same quantity replicated so that areas of the base it could in the same proportion onto the automatic pilot just as not passed to the instruments. Normally the first effect the captain would be operating the aircraft on the starboard side. Therefore the effect of water on the starboard side could at the time of the accident the result of the experiments leads to the conclusion that the automatic would not have been affected by any water in the system and he would not have been caused to land.
- The same conclusion cannot be reached as readily as relative to the system on the port side.

It is clear that the mere presence of water in the static line in the wing where the static ports are located will have no control effect on the instruments. In the environment of the final flight it could only have had such an effect if in the course of the final descent while passing these had moved along the line and "topped over" at stations 1000 feet from the cockpit area.

It is also clear that the water in the fuel tank had been present earlier in the line under the cockpit floor if it could have manifested its effects during the descent, attempt to find what the statics descended from 1000 feet to 100 feet supports the view that the pilot at that stage had the aircraft completely under control and that his statics were near operating norms.

Even if the presence of water in the wing lines be assumed the experiments conducted by the Board of Engineers and Inspectors to move to Station 1000 and back over during the final descent from 1,000 ft.

However, it is not possible to reproduce on the ground the precise circumstances re-enacted in the leading flight which lead to those 1-100. Thus, during the final descent, the static ports on the left side and it is possible that the slopes to which they were mounted were so great might have passed water to that gully located in the floor of a bay which topped over at station 1000 during the descent.

The experiments indicate that with 7 cc of water acting as this was in the rig it



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would pass over the fuselage during the flight of the accident and proceed along the static line towards the instruments. It is also shown that it would encounter with the maximum rate of descent at the end of the static line, and the altimeter would cease to measure the correct altitude. In fact, in this situation, with the altimeter decreasing, the altimeter would indicate a descent but the descent so required would be less than the actual. The required rate of descent for the aircraft was considered if the water height of a simulated height of between 1000 ft and 2000 ft in a descent it could cause the altimeter to read about 1,000 ft at the time when the descent itself had reached its level.

It is necessary to emphasize some other effects which the presence of water in sufficient quantities at the critical point would have had. The experiments indicate that the vertical speed indicator would require a lower rate of descent than the static line if the static line were to remain constant. The required rate of descent would then be increased as speed decreased until the end of the descent, would read just 5% higher than the static line, and the altitude of the vertical speed indicator would then be reflected by the vertical speed indicator.

Another factor which needs to be discussed is the likelihood that in a normal operation of the aircraft the captain might see that his descent was steeper than the altimeter indicated.

According to existing maintenance instructions in the Fokker Aircraft Maintenance Manual, the static line assembly for the CAV-VHSTF VH-STFC was related to the Board. In fact such a statement that the accidents were not attributable to the presence of water in the critical section of the static line in either the accident or the static line in the other accidents was written in the report. The experiments of the following sections will be able to show some temporary observations of the static system as the static wing was due to the formation of ice. The temperature readings during the period on which the critical air craft VH-STFC was holding over Mackay Airport indicated temperatures of minus 27 degrees Celsius that was at the time of the formation of ice in the static line.

Conclusion

The conclusions reached on this aspect of the matter by the investigating committee are as follows:

- The 1970 T-tail did not necessarily indicate exactly what would happen as an aircraft but gave the order of the effects.

- Current aircraft procedures have made it very certain of the possibility of water contamination of reference systems and it is believed to prevent unnecessary situations.

- The accidents to both VIECAV and VH-STFC were most likely caused by an ice blockage in the outboard part of the system.

- Water in the first officer's static system would have been present in the static wing prior to the accident.

- For water in the captain's static line started the accident it must have passed during the last descent at a height of between approximately 3,200 ft and 3,500 ft. It is depending on the quantity of water.

- At least 7 m of water would be necessary to cause sufficient error to account for the accident.



B-70 Throttle Motor

High temperature tests for B-70, capable of operating over temperature range of -65°F to 102°F, will serve as primary throttle control regime, replacing long used mechanical linkage. Motor, developed by North America's Los Angeles Division, has compressor bypass and a variable static inlet. Compressor bypass 8-70 will be held constant to rely on electric throttle control system and electronic linkage, to avoid problems of structural deflection and varying temperatures encountered during flight.

- It being necessary that there was an error in the static system the captain would have to ignore the readings of the attitude indicator, the artificial horizon and his own sensory abilities.
- The first officer would have to have been engaged for about 3 to 15 minutes in an activity which prevented him noticing the readings on his instruments.

It is also possible that he had been engaged in the task during the final descent at 1,000 ft but a suddenly in the static line in the aircraft and at 1000 ft above sea level at 1000 ft off the bottom 3100.

- Water in the static lines would be most likely to accumulate during the final descent as the aircraft would be in a steep nose down attitude and sit in the landing and would be unable to reach Station 3100 at the necessary 2,700 ft from commencement of the descent.

- These conclusions were in substance contained in a report submitted to the Board by Mr. Johnstone, Council of the Fokker Aircraft Co.

In relation to F12, it is said that the experiments of those meant to date associated to 70,000 flying hours and although water may have been present in the static line of each aircraft, as in other accidents, it has never yet been found in a critical position in the system. The final view of the Fokker Aircraft Company is expressed in the report of Mr. Conradi as follows:

"For water in the captain's static line to have started the accident it must have passed during the last descent at a height of between approximately 3,200 ft and 3,500 ft. It is depending on the quantity of water.

"■ That water was present in the static line at the moment of impact.

"■ That there was enough water to cause an error of 7 m. It is agreed that the error would be reduced from about 3100 ft to the accident, the greater part of which must have been present in that location during

all or most of the 34 flights prior to the last flight and that such water was all the time in such a form as not to show up by instruments or by the altimeter.

■ That this water did collect at a position in the lines where it would be put poised to trip over and did not collect at such a position during any of the 34 preceding descents and that this water stayed over the last 1000 ft of the descent but did not happen to the last 1000 ft of the descent during any of the 70,000 flying hours performed to date by Fokker F12."

- That the captain did not observe any fluctuations in the instruments during the period in which the water tipped over and collected in the lines. The maximum rate of descent would take about 1,000 ft descent.
- That the captain ignored the visual indicator rate of climb indicator, artificial horizon and his own sensory abilities.
- That the first officer did not monitor the captain's instruments.

- That, as the captain took over just after 12 m of the static line impact and did not notice it, it is difficult to say of any actual excess altitude, he did not perceive the delay or lag in his instrument readings within the period of 10 or 12 sec in which he would normally have expected to see signs of the excess height.

- That the first officer has certainly not been exonerated by my conclusion that the presence of water in the static line caused or contributed to the accident.

The possibility of water having accumulated over a period in the static line in the system, to which reference has already been made, is not easily predictable. It is unlikely that such water would be present at the commencement of the final descent of the aircraft as it was on the critical part of the system on the port side. If it did it has been shown that it could result in a triangulation failure of the altitude of the water in the static line in the aircraft. It is also possible that the static line was plumb at the start of this stage. Having regard to the presence of fog in the area, and the earlier described attempt to land both he and the first officer might have diverted some of their attention to the primary problem of landing. It is conceivable that they might not become aware of any abnormal behavior of the instruments at the time of the accident.

In the search for an explanation of an accident which is well beyond my knowledge, I am unable to make a positive finding that water in the static system did not cause or contribute to the accident. It would, at least in my view, be regarded as a possible cause but not probable.

The following are probably similar requirements to one of the pilot.

It is not possible on the evidence to determine whether Capt. Pollard or First Officer Dene was flying the aircraft at the relevant time.

It is clear that Dene was to undergo a procedure on the aircraft, and it is reasonably accepted that for some part of the flight at least, he was at the controls. Pollard, when the aircraft left Rockhampton, was occupying the port side or captain's seat. But it is not known to me if it can be assumed by the fact that the station seat was not occupied the body of First Officer Dene when it was recovered. The answer

therefore with the air controller at Mackay possibly were conducted by Pollard, and the substance of those which preceded the obvious attempt to land suggest that he flew the aircraft at that time.

However this may be, there is no evidence to support the claim that the first officer flew the aircraft other than the fact that the report referred by Capt. Pollard concerned with the captain's seat being at the forward position at the moment of impact. There has also it is not possible to know with certainty what was done by the first officer. I think it is probable that Capt. Pollard flew the aircraft in the final descent.

He was a highly experienced pilot with a long flying experience. There is evidence in relation to this flight that in his career reported to the Board, he had no accident with a relationship. This does not matter as far as I would conclude that he was regarded as an sound grounds that an element of risk was involved. I am not prepared from these statements to draw any inference that his might damaged roads were in any way related to capture of his aircraft or passenger was involved.

Altitude Error

The kind of error in the reading of the altimeter which in the final stages would account for the accident, in case in which a static line was not available, would be an altitude of over 1,000 ft above an altitude measurement that a measurement of 100 ft over 1,000 ft. It seems unlikely that a pilot of such experience as Capt. Pollard would be unable to measure an altitude of 100 ft or 1,000 ft. The first officer may have been flying the aircraft at a difficult to attach with any certainty an exact enough plot more particularly as such a mistake could only occur after he had descended to 100 ft before he or the first officer being aware that the aircraft was descending. It is also possible that the first officer did not notice the error at this stage.

Having regard to the presence of fog in the area, and the earlier described attempt to land both he and the first officer might have diverted some of their attention to the primary problem of landing. It is conceivable that they might not become aware of any abnormal behavior of the instruments at the time of the accident.

Similar considerations apply again to the possibility of static line contamination of the static line system, as has already been mentioned the extreme descent. If the aircraft followed a curve similar to that which has been plotted in an assumed course it was on in the final stages of the descent, it is possible that the aircraft was flying directly below the altimeter and it is conceivable to assume that the pilot would disregard the safety preconditions for the use of an altimeter in such circumstances.

For the reason I am not entitled that the accident did not in case of the pilot in rendering the altimeter to be a open pipe or pressurized disregarding by loss of the information his instruments provided.

The most that can be said is that some part of the pipe in rendering the altimeter has not been able to be explained as a possible cause of the accident.

I summarize my conclusions as to the accident and the cause of the accident as follows:



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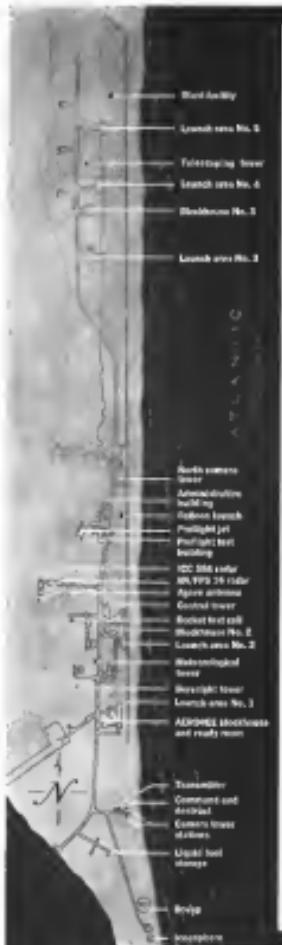
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NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

Auditorium, covered the area some 70 m. northward of Mackay Airport.

- The aircraft was fatally wrecked.
- The aircraft caused a crew of four and 25 passengers, all of whom were lost in a fire, to be killed.
- At the time of the accident the aircraft was approaching the Mackay Airport with a view to landing.
- A clearance to make a visual approach was properly given by the air controller at the time of the accident.

■ The weather conditions at the time presented no hazard to a visual approach and landing, and all the radio navigation aids and airport lighting facilities were functioning satisfactorily at all relevant times.

■ The pilot and the first officer were allegedly licensed, qualified and competent officers.

■ They were both in good health and there is nothing to suggest that did not have complete control of the aircraft or were at any stage rendered incapable of fully performing their functions or reflexes to the required standard.

■ Used at least 10 g. as conditions on the aircraft were possibly normal.

■ There is no evidence to suggest that between 10 and 10.05 g. in the condition of the aircraft did not continue.

■ The aircraft descended the water with six seconds' engine power at a speed of not less than 160 knots.

■ The aircraft does not support any conclusions other than the aircraft and its engines were functioning normally.

- The aircraft descended rapidly via the sea at a flat trajectory before impact, carrying a distance downwind and banked to starboard at an angle of 30° between 1 and 10 deg.

■ The aircraft descended towards the sea at not less than 900 ft/min.

■ The evidence supports the view that the flattest trajectory of the aircraft was attained immediately after impact.

■ There is no evidence of fire or explosion having occurred at any time prior to or subsequent to the impact.

■ The instrumentation of the accident aircraft had been satisfactorily repaired before the aircraft was last flown at a lower altitude than the point of impact.

■ The evidence does not support a conclusion that the instruments or any of them were not functioning properly.

- It is considered that the evidence does not support a conclusion that the aircraft was in the post-strike attitude of the aircraft and the evidence does not provide a conclusion that water in the static ports caused as contemplated in the instrumentation.

- The evidence does not confirm the existence or the shape of the contours of water in the static ports as exists as a modification of the instrumentation system as the evidence has not established a possible cause of the accident but the evidence points to the fact that such a happening may be possible.

- The evidence does not provide any finding that the engine or the fuel system failed during the accident or that the aircraft was unable to gain sufficient altitude to the water surface and which

- The evidence does not furnish any finding that the engine or the fuel system failed during the accident or that the aircraft was unable to gain sufficient altitude to the water surface and which

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radiotherapy or observation, which was needed.

• The existence of very solar eclipses makes the problem that radio silence under cloud observation. In the past, from the results at the altitudes, small errors are possible.

• The evidence does not support a can theory that radio silence may partly consist of the presence of clouds, possibly the sun that could be excluded.

• He should strike the set at a time when he already should have been less than 1,000 ft. but it is impossible to say how this occurred.

It has proved to be impossible to reach any conclusions as to the cause of the second losses, these being on account of the failure, there are no means of ascertaining what occurred on the aircraft in the last few seconds of its flight. It would be desirable that some colleagues who have any knowledge of aircraft systems which might have influenced the capture and the first officer during that period set up the readings of the flight instruments up to the moment of impact.

Concerning the Department of Civil Aviation's comment that the pilot of the DC-9 did not know his position, the author has worked on components before in flight in order which would be capable of providing such information as the course of an accident such as this. I can advise that considerable development has taken place here and has been related to such instruments but have not informed that the Department had not yet had presented to it an instrument which is sufficiently perfected to patch the institution of such instruments in aircraft systems.

The author feels that the Department has done well in that the writer is commended. It is recommended that the search for such an instrument should be pursued on the hope that synthetic flight recorders can be installed on all future flights.

There would be a legitimate objection to the present notion which is sufficient to see more happen. Many of the long distance air routes are subject to inspection of all flights prior to a year. In obtaining such an angle of view, the opinion is now found in P-75 VTS 198.

in the flight proceeds so that only the results of an immediately preceding descent will at one time be preserved and that the recording of the most recent descent will cause the tape to stop at the instant of each flight. The insulation of such an instrument is not therefore necessary subject to the type of operation in which it has to be used.

The problem of the recording of the distance travelled in its flight is also



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NORTH AMERICAN AVIATION, INC.**



WHO'S WHERE

(Continued from page 18)

Changes

Walter B. Smith, chief engineer, the Metra Co's Goss (Pa.) Division at Cape Canaveral.

Three new laboratories have been formed within the Advanced Laboratories of Sylvania Electric Products, Inc., Buffalo, N.Y.: and the three have been designated as managers: Dr. Robert L. Strode, Advanced Communication Systems Laboratory; Dennis W. Cole, Product Development Laboratory; Albert W. Puhlik, Product Engineering Laboratory.

R. B. Rogers, assistant manager, Thermal and Acoustical Systems Branch, Avco Corp., Woburn, Mass., has been promoted to manager.

Steve J. Frazee, director-business planning and development, Marconi Components and Devices Group, Andover Co., Woburn, Mass., has been promoted to manager. Michael J. Kates, formerly manager of the Marconi Components Division, Edward L. Behrakis, formerly manager of the Katherer Research and Power Div., has been promoted to manager.

James R. Connelly, director of field engineering, Interim Components Co., Cedar Knob, N.J., division of Sperry Rand Corp., has been promoted to manager. Charles V. Tamm, manager, Consumer Products Manufacturing, Sylvania General Electric Co.'s Light Mfg. Electronics Department, Utica, N.Y.

Wayne D. Stewart, manager of the newly formed Special Projects Division of Angel Corporation's Liquid Rocket Plant, Avco Corp., has been promoted to manager.

Dr. Charles L. Felt, manager Las Vegas (Nev.) operations of Edgerton, Germeshausen &歌特, Inc., Boston, Mass.

Charles S. Jones, chief engineer of the Wichita Laboratory, Paul M. Ladd, manager of Link Division of Control Precision Inc.

Dr. Harold R. Leinenberg, reconnaissance systems head, Westwood Division of Honeywell Inc., Fort Lee, N.J.

Walter E. Hansen, general manager, Infrared Division, Varian Associates, Inc., Santa Clara, Calif.

Edgar M. Sheard, director of research and development, Special Devices, Inc., Pasadena, Calif.

Elio W. Winkler, manager Communications and Data Processing Laboratory, Malibu Radio Division, Phoenix Electric Corp., Los Angeles, Calif.

Dr. T. J. Salter, manager space engineering, Phoenix Control Division of the Phoenix Corp., Glendale, Ariz.

Bern Cohen, division manager Anti Submarine Warfare Division, Lear Electronics Corp., New York, N.Y., and Santa Barbara, division manager, Phoenix Division, Phoenix Corp.

Douglas B. Orfield, manager, Propulsion Development Branch, Marcal Technology Corp., Stow, Ohio, division of Marcal Corp.

James L. Conner, manager of advanced planning, Thorol Chemical Corp.'s Rocket Dynamic Center, Oxford, Utah.

John F. Lassiter, manager of product development, Precision Products Department of Norcross, a division of Northrop Corp., Norcross, Ga.

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- Acoustical studies
- Reconnaissance sensors
- Optical systems
- Infrared
- ECM and ECCM systems

TEST

- Preparation of functional test procedures
- Laboratory and flight evaluation of materials and components
- Digital computer programmes
- Establish criteria and interpret test results

DESIGN

- Electro-Mechanical systems or component design evaluation
- Selection or design of electrical/electronic equipment or systems
- Electronic system or component application and design evaluation
- Navigation and communication systems — design evaluation
- Electrical and electronic control systems
- Circuit design and component selection
- Defensive and ECM design evaluation
- Instrumentation design
- Test equipment design
- Antenna design
- System installation configuration design
- Ground support equipment

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An Industry First

4.3 MM BALANCED DUPLEXERS 68.75 - 70.75 kMc

Bomac Laboratories presents a 4.3 Millimeter Balanced Gas Switching Duplexer... an industry first from Bomac's advanced development in radar and microwave components.

The BLP-017D duplexer is the first ever designed for 4.3 mm operation. This rugged short-slot hybrid duplexer assures reliable service under severe environmental conditions. Operable in excess of 500 hours, at temperatures from -40° C. to $+85^{\circ}$ C. It's lightweight — weighs less than 4 oz. And it's small: volume, only 1.4 cubic inches.

Switches 15 kW peak power at 0.0006 duty cycle. Available in many configurations to meet customer requirements. Applicable to high definition radar systems.



BLP-017D Duplexer
(shown half-again actual size)

Electrical Characteristics:

- 68.75-70.75 kMc ■ 2.0 μ s Recovery Time
- 0.005 erg Spike Leakage ■ 5.0 mw Flat Leakage
- 0.9 db Duplexer Loss ■ 1.3 VSWR

You'll want to know more about the BLP-017D Duplexer, and other quality Bomac microwave tubes and components. Write for technical literature.

BOMAC laboratories, Inc.

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